REPORT

ON

THE TREATMENT AND DISPOSAL OF THE SEWAGE OF THE CITY AND COUNTY OF SAN FRANCISCO, CALIFORNIA

TO

MR. W. H. WORDEN, DIRECTOR
DEPARTMENT OF PUBLIC WORKS
SAN FRANCISCO, CALIFORNIA

BY

BOARD OF CONSULTING SANITARY ENGINEERS

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MAY, 1935

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San Francisco, California

May 6, 1935.

Mr. W.H.Worden, Director
Department of Public Works
City and County of San Francisco

Sir:

Pursuant to your authorization, we have conducted investigations and herewith present our report upon the treatment and disposal of the sewage of the City and County of San Francisco, California.

While these investigations were intended to deal primarily with the Marina and Baker's Beach problems, these problems were found to be so closely interrelated to the problems of other sewerage districts that it has been necessary to study the subject of sewage disposal for the entire city. The need for this more comprehensive consideration was recognized in the City's agreement with us, in these words:

> "Whereas the method of disposing of said sewage through said works (meaning Marina and Baker's Beach) and the results to be secured from such disposal of said sewage, are intimately connected with and affected by the method of disposing of the sewage from other sewers which discharge at several points along the water front;"

and in the specific instructions, requiring us:

"a. To go over preliminary reports and studies prepared by my City Engineer in connection with these plants.

"b. To inspect all local conditions affecting the problem.

"c. To advise as to the general sewage disposal scheme that should be adopted.

"d. To advise as to the proper location of plants and outfalls.

"e. To recommend type of process that should be adopted and to estimate cost of construction and operation."

At present, the sewage is discharged from six sewerage districts as follows:

1. Southeast sewerage district through 18 outlets to the Bay.

2. North Point sewerage district at the bulkhead in the slip between Piers 37 and 39.

3. Marina sewerage district at the shore at the foot of Pierce Street.

4. Baker's Beach sewerage district at or near the shore just west of Lobos Creek.

5. Mile Rock sewerage district, embracing the West Richmond and Sunset areas and the territory lying easterly of the old Rancho de la Merced, and discharging at the shore a short distance easterly of Point Lobos.

6. Southwest sewerage district (Vista Grande), comprised of undeveloped territory in the extreme southwest corner of the City and County of San Francisco together with Colma and Daly City and adjacent territory in San Mateo County, discharging through a tunnel under the Fort Funston Military Reservation at the shore line approximately one mile south of Fleishhacker Pool.

As a result of our studies of the data previously procured,

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As a result of our studies of the data previously procured,

and additional information secured by the City Engineer under our supervision, we have found that:

1. Insanitary conditions exist at a number of points along the entire Bay, Strait, and Ocean waterfront.

2. Unsightly and offensive waters, and deposits of sewage solids, exist in the vicinity of the North Point outlet; sewage matter from this outlet is clearly visible along the shore for long distances; and bacterial contamination of shore waters at times extends at least as far westerly as the Marina.

3. The discharge from the Pierce Street outlet causes gross pollution of shore waters in that vicinity, the contamination at times extending long distances east or west from the outlet in accordance with the direction of the tidal currents.

4. The sewage from the Baker's Beach outlet causes gross pollution of the recreation beaches and waters in this vicinity and the contaminated water extends long distances east or west in accordance with the direction of the tidal currents.

5. The sewage discharged from the Mile Rock outlet causes gross pollution in the immediate vicinity and serious contamination for long distances, even extending southerly along the Ocean front.

6. A considerable stretch of the southwest shore line is polluted by the sewage discharged by the Vista Grande outlet.

The situation and configuration of the San Francisco Peninsula with relation to the waters of San Francisco Bay, Golden Gate Strait, and the Pacific Ocean, are such that the greatest advantage economically feasible should be taken of the large diluting volume of these waters for the disposal of the sewage, subject to the limitation that the sewage, directly or indirectly, shall not create conditions objectionable to the senses, and shall not endanger the public health or that

of individuals frequenting the beaches and utilizing the shore waters for recreational or other purposes.

We make the following specific recommendations:

1. That the sewage of the existing Southeast sewerage district be intercepted and carried to treatment plants at or near China Point, Hunter's Point and North Point, in accordance with the general plan which the City has been following.
2. That the sewage of the existing North Point sewerage district and of a portion of the existing Southeast sewerage district be pumped at the proposed North Point sewage treatment plant; and that the sewage of the existing North Point, of a part of the existing Southeast, and of the Marina sewerage districts be treated to remove, (a) grit, (b) oil, grease, and other floating matter, and (c) the coarser portion of the suspended material, by means of racks, grit chambers, aerated skimming tanks, and fine screens; and that the treated sewage be discharged at a distance of 2000 feet from the bulkhead line, in water at least 50 feet deep, through a submerged outlet pipe equipped with a system of diffusion nozzles.

3. That the sewage of the Marina sewerage district be pumped through a force main to the North Point treatment plant, the force main being laid for a part of its length within the tunnel of the Belt Line Railroad under Fort Mason.
4. That the North Point sewerage works be constructed as soon as the necessary funds become available, and that, pending their construction, the sewage of the Marina sewerage district be discharged into the Beach Street sewer in The Embarcadero, whence it will flow into the slip between Piers 37 and 39.
5. That land for the North Point sewage treatment plant be acquired as soon as financially practicable, even though plant construction cannot be undertaken at that time.
6. That the sewage of the major portion of the Baker's Beach sewerage sub-district be diverted and conveyed by gravity through a sewer tunnel from the intersection of Twenty-fourth Avenue and Lake Street to the intersection of Thirty-fourth Avenue and Fulton Street; thence through a sewer in Fulton Street to Forty-sixth Avenue, thence to a proposed treatment plant in Golden Gate Park; and that the sewage of the remainder of the Baker's Beach sub-district be pumped at an underground pumping station situated at the northern end of Twenty-fifth Avenue

North, to the proposed sewer at Twenty-fifth Avenue and Lake Street.

7. That the sewage of the major portion of the West Richmond sewerage sub-district be diverted from the existing trunk sewer in Fulton Street at Forty-sixth Avenue and combined with the sewage from the Baker's Beach sub-district at that point; and that the remainder of the sewage of the West Richmond sub-district be concentrated at the existing pumping station at Forty-eighth Avenue and Fulton Street, and pumped through a force main to that same point whence all the sewage would flow by gravity through a proposed sewer leading to the treatment plant.

8. That the sewage of a portion of the Sunset sub-district be diverted and conveyed by gravity from the existing sewer in Lincoln Way at Forty-fifth Avenue to the treatment plant; and that the sewage of the remainder of the Sunset sub-district be diverted and pumped from the existing Mile Rock trunk sewer in Golden Gate Park to the treatment plant.

9. That the sewage of the Mile Rock sewerage district, comprised of the Baker's Beach, West Richmond and Sunset sub-districts, be treated to remove (a) grit, (b) oil, grease, and other floating matter, and (c) that portion of the suspended solids which will settle in a moderate period of time, by means of racks, grit

chambers, aerated skimming tanks, and sedimentation tanks; that as much as needed of the effluent be furnished for use in the Park, and that the remainder after chlorination be discharged temporarily into the existing Mile Rock trunk sewer and discharged through the present outlet at the north shore a short distance eastward of Lobos Point; and that the sludge from the sedimentation tanks be subjected to biological digestion in gas-tight tanks, that the digested sludge be dewatered by means of vacuum filters, and that the dewatered sludge be furnished for use in the Park, upon municipal golf courses, and other areas.

10. That, in anticipation of the eventual need of providing for the discharge in deep water well offshore of the effluent from the Golden Gate Park treatment plant above described or for complete treatment in the Park, borings and other data be secured which will make possible a reliable estimate of the efficacy and cost of discharge in deep water in comparison with complete treatment; and that, when necessary, the more advantageous of these plans be adopted and executed.

11. That negotiations be undertaken immediately with the authorities of Daly City and the adjoining areas in San Mateo County, which are tributary to the Vista Grande sewer outlet in the extreme southwest corner of the City and County of San Francisco, to the end

that provision be made for eliminating the nuisance now existing, due to the sewage from these areas, either by complete treatment and appropriate disposal of the effluent or by pumping through a force main into the sewers leading to the treatment plant in Golden Gate Park.

12. That the City request the War Department to make provision for delivering all of the sewage of the Presidio and Fort Mason into the sewerage system of the City in order that it may be properly treated together with the City's sewage.

With the completion of the works recommended and their faithful and efficient operation, the sewage will be disposed of in as effective and economical a manner as possible having due regard for the suitable protection of the beaches and shore waters from sewage pollution.

It is to be noted that this Report recommends the removal of the sewage of the Marina sewerage district by pumping into the North Point district where it is proposed to be treated in the future in combination with the sewage of that district.

In the meantime it should be understood that the removal of the sewage as recommended will definitely eliminate the major source of contamination of shore waters in the vicinity of the Yacht Harbor. Under certain conditions of tide, as discussed in the report, some contamination of these waters does

and will continue to occur from the sewage discharged at North Point. However, the conditions would not be changed in this respect even though a plant for the complete treatment of the sewage of the Marina district were constructed within that district.

At present the shore waters of the Marina district, grossly polluted with sewage, move with the tides back and forth continuously along its water front. Water contaminated with sewage by the North Point outfall will be required to travel some two and one-half miles before reaching the Yacht Harbor.

Prior to the building of the treatment plant the periods during which the contaminated waters from North Point will be found in the vicinity of the Yacht Harbor under the recommended project will be brief and the degree of such contamination relatively small.

CONSTRUCTION COST ESTIMATES.

The estimates of the construction cost, including engineering and contingencies, of the works herein proposed are summarized in the table below in two parts; first, those works recommended for immediate construction totaling $1,300,000, and second, those recommended for later construction totaling $2,250,000.

A. Work recommended to be done from present bond funds.

North Point and Marina Sewerage Project.

Marina Pumping Plant and Force Main, including repairs to Pierce Street sewer at outlet end	$ 252,000

Richmond-Sunset Sewerage Project.

Baker's Beach Pumping Plant, Diversion Structures and Connecting Sewer Lines to treatment plant	465,000
West Richmond Pumping Plant and Force Main, and Sunset Connecting Sewer Lines	40,000
Richmond-Sunset Treatment Plant	543,000
Total	$1,300,000

B. Work recommended to be done as soon as funds are available.

North Point and Marina Sewerage Project.

Land for treatment plant site	$ 600,000
North Point Treatment Plant, including Pumping Plant, Sewer Line Changes and Outlet Pipe to bulkhead line	1,250,000
Outlet Pipe to approximately 2000 feet from bulkhead line, including Diffusion System	400,000
Total	$2,250,000

Richmond-Sunset Sewerage Project.

Outlet Pipe to deep water or Complete Treatment in Golden Gate Park	Not estimated.

The cost of the work to be done in the Southeast and the Southwest sewerage districts has not been estimated because of the lack of necessary information regarding the general details of the work required.

ESTIMATED COST OF OPERATION OF TREATMENT WORKS AS OF 1940.

Marina Pumping Station.

Power and lighting	$8,000		
Labor	2,400		
Materials and supplies	900		
Total			$11,300

Richmond-Sunset Sewerage Project.

Twenty-fifth Avenue North Pumping Station.

Power and lighting	$2,400		
Labor	1,050		
Materials and supplies	350		
Sub-total		$3,800	

Forty-eighth Avenue and Fulton Street Pumping Station.

Power and lighting	$ 900		
Labor	700		
Materials and supplies	200		
Sub-total		$1,800	

Richmond-Sunset Treatment Plant.

Power and lighting	$5,000		
Labor*	36,000		
Materials and supplies **	1,400		
Chlorine, ferric chloride and other chemicals	13,300		
Sub-total		$55,700	
Total			$61,300

* Includes delivery of sludge but not spreading.
** Cost of water required, 65,000 gallons a day, not included as it is a matter of inter-departmental bookkeeping.

In closing, we desire to acknowledge the cooperation of His Honor the Mayor, the Chief Administrative Officer, the Director of Public Works, the City Engineer, and the Director of Public Health.

We record our appreciation of the assistance rendered by Messrs. Ohmen, Tegtmeyer, Stahle, and Benas of the Bureau of Engineering; of Dr. Annie D. MacRae, Director of Laboratories, Department of Public Health; and of Mr. C. L. Cook, Chemist in Charge of Testing Laboratory, Department of Public Works. Mr. Benas has been in direct charge of all field and office studies.

Respectfully presented.

(Signed) Harrison P. Eddy

(Signed) Charles Gilman Hyde

(Signed) Clyde C. Kennedy

(Signed) Leon B. Reynolds

Board of Consulting Sanitary Engineers.

REPORT

- REPORT -

UPON THE TREATMENT AND DISPOSAL OF THE SEWAGE OF THE CITY AND COUNTY OF SAN FRANCISCO, CALIFORNIA

May 6, 1935

INTRODUCTION

The Problem Stated

The shore waters of the City and County of San Francisco are more or less polluted with sewage throughout their entire length from the southeast boundary around to the southwest city limit. The length of shore line, bordering upon San Francisco Bay on the east, Golden Gate Strait on the north, and the Pacific Ocean on the west, is approximately 23 miles.

Virtually the entire west coast south of the Cliff House is comprised of one magnificent stretch of wide, sandy beach about five miles in length facing the Pacific Ocean. Along the north shore, from the Cliff House to Aquatic Park, are to be found ten beaches of some magnitude and several others which are small and not readily accessible. In the southeasterly portion of the city there are two beaches worthy of special consideration.

At the present time the City and certain United States Government establishments maintain 31 sewer outfalls through which sewage is constantly being discharged at the shore line or in small estuaries and channels adjacent thereto. Of this number, 19 are along the east shore, 11 are on the north shore, and one is on the west coast. In addition to these outfalls which regularly discharge sewage into the coastal waters, there

are at least 10 storm overflows which occasionally contribute sewage, diluted with storm water, hereinafter called storm sewage, in quantities varying from comparatively small to relatively large volumes. The storm discharges are infrequent in the warmer portion of the year and do not appear to be seriously detrimental.

The people of San Francisco, as a community, are an out-of-door, recreation-seeking group. On fine days, during the seven-month period, April to October, they flock to all available beaches and shores for various types of recreation, including swimming. On warm days in the other months of the year the beaches are frequented, but swimming is not largely indulged in.

The presence of sewage is shown by fecal matter and other litter along the beaches and is demonstrable in the coastal waters at nearly all points by laboratory tests. This pollution has its public health implications in that it is dangerous to swim in such heavily polluted waters or to use beaches fouled with fecal matter. The esthetic implications likewise are not to be overlooked or condoned.

If the people of San Francisco are to enjoy with safety and without restraint the many beaches which nature has provided, it is obvious that the sewage must be disposed of in such manner that the untoward conditions above recited shall not obtain, particularly during that period of the year which is climatically favorable to the recreational use of the

beaches.

It is the purpose of this study and report to determine and recommend the most suitable program of sewerage improvements which will return the beaches and coastal waters to a safe and attractive condition.

Appointment and Duties of Board of Consulting Sanitary Engineers

The Board of Consulting Sanitary Engineers was appointed by W. H. Worden, Director of Public Works, under Department of Public Works Order No. 629, approved July 25, 1934. The terms of this Order prescribed that the Board shall "investigate and report, with estimate of cost, upon the most economical and reasonably effective method of disposing of the sewage at Baker's Beach and the Marina through sewage disposal plants to be erected out of Federal Public Works Administration funds."

As explained later, the pollution of the waters of the Marina and Baker's Beach is caused in part by sewage from other portions of the city, notably that discharged at North Point and at Mile Rock. It therefore has been necessary to give some consideration to the broad problem of the disposal of the sewage of practically the entire city.

At the outset C. G. Gillespie, Chief, Bureau of Sanitary Engineering, Department of Public Health of California, was appointed to serve as an ex-officio member of the Board and did so serve for several months. Later, when it became evident that a treatment plant and new outlet pipe in the vicinity of Baker's Beach would not be recommended, but that the sewage would be di-

verted therefrom, Mr. Gillespie resigned on the ground that this particular problem, which was so vitally related to China Park, having been solved, he could be relieved from further duties in connection with the work of the Board. The remaining members of the Board appreciate the helpful work of Mr. Gillespie while a member and regret his retirement.

Conditions Demanding Present Study and Report.

Two circumstances, in particular, have contributed to a demand for an immediate solution of the problems of shore pollution. One of these was the agitation for the purchase, without further delay, of lands to create a new state park to be known as China Park. The other was the application by the City and County of San Francisco for Public Works Administration funds to cover the cost of certain projected sewerage improvements, including treatment plants, to prevent the serious pollution at Baker's Beach, at China Cove, and at the Marina.

The Board of State Park Commissioners refused to proceed with the purchase of the lands necessary to the China Park development unless or until there was assurance that the pollution of China Cove and Baker's Beach would be remedied. Upon representation by the administrative authorities of the City and County of San Francisco that an impartial board of sanitary engineers would be appointed to consider and report upon the matter and further, that the recommendations of that board as related thereto would be faithfully carried out, the State Board of Park Commissioners contributed its share of the funds necessary to the purchase of the China Park property. The City was thus committed

to the appropriate treatment and disposal of the sewage now discharged at Baker's Beach.

Relation of Sewer Outfalls to Shore Pollution.

There are at present four main outfalls of the City and several others built and maintained by United States Government establishments, which are responsible for the pollution of the shores and shore waters of San Francisco. From a study of the directions and velocities of tidal currents along these shores and of the results of a comprehensive series of bacterial examinations of these waters, it shortly became apparent that the pollution effects of these several outfalls were closely related. It was discovered, for example, that it would be of little avail to treat and suitably dispose of the sewage now discharged at Baker's Beach unless that now discharged at Mile Rock was also suitably treated and disposed of. Furthermore, the sewage discharged at North Point, between Piers 37 and 39, undoubtedly pollutes the shore waters as far westward as the Marina, while both the North Point and Marina outfalls contribute to the pollution of Aquatic Park Beach and waters.

Data Initially Available to Board.

At the outset the Board was furnished with a comprehensive "Preliminary Report on Studies in Connection with Proposed Sewage Disposal Improvements Along the North Shore of San Francisco" dated April, 1934, hereinafter called the Preliminary Report. This report was prepared by the staff of the Bureau of Engineering under the direction of John J. Casey, City Engineer. It contains a fund of basic information which has been utilized by the

Board and has furnished the foundation for further field and office studies.

In addition to the material contained in the Preliminary Report the City Engineer has furnished the Board with much other information and with maps, drawings, surveys, and estimates which have been of material value.

The "Report upon a System of Sewerage for the City and County of San Francisco," 1899, by C.E.Grunsky, Civil Engineer in Charge, and Marsden Manson and C.S.Tilton, Associate Engineers and approved by Rudolph Hering, Consulting Engineer, has been helpful. That report clearly defines the sewer system which, as now built, conforms closely with that therein recommended.

Field, Laboratory, and Office Studies

The field work and studies undertaken in connection with the Report of this Board have involved the following: surveys of various treatment plant sites and routes for sewers; hydrographic surveys and soundings of several possible locations for outlet pipes; construction of weirs and other measuring devices, and the gauging of the flow contributed by major sewerage districts; extended observations of tidal current directions and velocities by means of floats and dyes; bacterial analyses of shore waters to determine the extent of contamination; sampling and analysis of the sewage contributed by typical districts and certain field tests and observations to reveal its composition and condition.

All bacterial samples were examined for B. coli at the laboratory of the Department of Public Health. The chemical analyses of sewage were made in the testing laboratory of the

Department of Public Works.

The office work and studies have embraced the compilation of many sorts of data and the preparation of maps, drawings, diagrams, and charts; the making of population estimates and forecasts; the study of climatological statistics relating to rainfall, winds, and temperature; the layout and tentative design of sewers, outfalls, pumping stations, treatment plants, and outlet pipes; and the estimation of construction quantities and costs.

CLIMATOLOGY OF SAN FRANCISCO

Temperature

The climate of San Francisco is equable. The records of the Weather Bureau of the United States Department of Agriculture show that only twice in 63 years has the temperature dropped below the freezing point, with an absolute minimum of 27°, and only seven times in this period has it dropped below 35°. Only twice has a temperature above 100° been recorded. Extremes approaching these limits are rare and usually of short duration, two or three days at most. The average temperature throughout the day does not vary more than 15° nor is the range throughout the year much more than 15° for corresponding hours of the day. This is shown by the temperature isopleths on Plate 1. This uniformity is indicated graphically on Plate 2, which shows maximum, average, and minimum monthly temperatures. The normal daily mean temperature is given on Plate 3 and the average and

extreme temperatures by months on Plate 4.

Wind

As with temperature, a remarkable uniformity prevails with respect to the direction and velocity of the winds in San Francisco. Sudden gales of considerable intensity occur but they are of short duration. Periods of calm occur but they rarely continue through the day. The winds blow with great regularity from the west and southwest. Seasonally there is some variation. Winds from the north, northwest, and northeast occur most frequently during the winter and spring months and southeast winds prevail during periods of rain. In the early morning hours, even in the summer season, winds may blow from the north and northeast.

While a general statement as to direction of the prevailing wind for many places may be quite misleading, it is not so in the case of San Francisco. For more than 75 per cent of the time, from April to October, the wind blows from the southwest and west. This is shown on Plate 5 as a 15-year average from records of the Weather Bureau.

The hourly wind directions and velocities for the 12 months, March, 1933 to February, 1934, are shown on Plates 6-9.

The average wind velocity does not exceed 21.5 miles per hour as shown by isopleths on Plate 10. Throughout the afternoons of the seven months, April to October, the wind velocity averages more than 13 miles per hour. The general trend of wind movement is parallel to the north shore and on shore along the west coast. These sections, as has been

pointed out elsewhere, embrace all recreational beach areas except those in the extreme southeasterly portion of the city.

Rainfall

The rainfall in San Francisco occurs chiefly in the winter months. This is shown on Plate 11 which gives the average rainfall distribution by months as the maximum, average, and minimum for the 85-year period for which records are available; also the average number of days in each month when rainfall of 0.01 inch, 0.25 inch, and 1.0 inch occurred. It may be stated that the intensity of rainfall in San Francisco is low as compared with other communities in the more arid parts of California or elsewhere in the United States.

The maximum, average, and minimum monthly rainfall is shown graphically on Plate 12.

Of the recorded average annual rainfall of 21.9 inches, 3.6 inches or 17 per cent fell in the seven months, April to October. Of the 67 days a year showing precipitation of 0.01 inch, 18 days or 27 per cent were in the 7-month period. For the 26 days showing precipitation of 0.25 inch, four days or 16 per cent were in the 7-month period. On only a few days in the 63-year period, averaging less than one a year, has a precipitation of 1.0 inch occurred in the 7-month period.

Since the period, April to October inclusive, covers the time when the beaches are most used, the character of the storms in this period is of importance as showing the extent to which storm waters contribute to fouling the recreational beaches. Plate 13 shows the number of hours that rainfall of

the stated intensity, as a yearly average and as a cumulative total for all high intensities, occurs during the 7 month period. It appears that, of the hours of rain in the 7-month period, 63 per cent have intensities of less than 0.04 inch per hour.

The number of storms and total hours of rainfall during storms of different intensities below and above 0.04 inch per hour for this period are shown in detail on Plate 14. From this tabulation it appears that, of 26 storms bringing rain for a total period of 65 hours, seven storms gave an intensity of between 0.02 inch and 0.04 inch per hour. In 8.3 storms an intensity of 0.04 inch was exceeded. These average data are for the 27 years ending December 31, 1933.

Plate 15 shows the frequency with which rains of different intensities occur during the warmer season, April to October.

Plate 16 shows the number of days from April to October when there was a rainfall intensity greater than 0.01 inch per hour, during the 15 years, 1915 - 1929, and emphasizes the infrequency of runoff-producing rains during the season when the beaches are utilized commonly for recreation.

Unless occurring during a part of a period of more intense precipitation, rains of 0.01 inch per hour will not produce a runoff and can be disregarded in a study of the

effect of storm sewage discharge.

Rains having an intensity of 0.01 to 0.04 inch per hour occur on the average about once a month during the 7-month period and their aggregate duration is 22.3 hours, or 0.4 per cent of the time. Even in an abnormally wet season, such rains may be expected only about once in two weeks, and their aggregate duration will be about 50 hours, equivalent to 1 per cent of the time.

Rains of greater intensity are slightly more frequent on the average although their duration is equal to about the same proportion of the total time, 0.4 per cent. Even in abnormally wet years such rains may be expected only about once in two weeks.

GEOGRAPHY AND TOPOGRAPHY

Area and Zoning

The total land area embraced within the city limits of San Francisco is 30,700 acres or 48 square miles, including an area of considerable size in the southeast corner now submerged but which it is proposed to reclaim to the projected bulkhead line. Included in this total are 3,250 acres devoted to municipal parks and playgrounds, of which Golden Gate Park occupies 1,013 acres; also 2,068 acres in United States military reserves, of which the Presidio occupies 1,435 acres. The zoned areas are: residential, 14,110 acres; commercial, 1,875 acres; industrial, 3,400 acres; total, 19,385 acres, or about 60 per cent of the total land area.

Boundaries

The area within the city limits, unchanged since 1899, is roughly seven miles square with its boundaries practically corresponding with the cardinal points of the compass. The city is bounded on the east by San Francisco Bay, on the north by Golden Gate Strait, on the west by the Pacific Ocean, and on the south by San Mateo County. The northern half of the east shore line is already developed with piers and the southern half may be similarly developed in the future. Of the eastern third of the north shore, that part which extends from Aquatic Park westerly to the Presidio, except the portion near the Fort Mason docks, is devoted largely to recreational use. The western two-thirds borders the Presidio, China Park, and extensive recreational lands under the jurisdiction of the Board of Park Commissioners. The western shore comprises a rocky headland at the north end and five miles of attractive sandy beach, most of which is available for recreational use. The Esplanade and Great Highway parallel this shore in its central portion.

Physical Features.

The city occupies the northern end of the San Francisco Peninsula. A low spur of the Coast Range extends northward through the city slightly west of the central axis and has a maximum elevation of over 900 feet at Mount Davidson, Twin Peaks, and Mount Sutro. This spur divides the city into two main drainage areas, one sloping generally westward toward the Pacific Ocean and the other generally eastward toward San Francisco Bay. In the main the topography of the city is hilly, but the northeastern and eastern areas, some portions

of which have been reclaimed by filling to the present bulkhead line, are low and flat. Much of the western part of the city has been built upon sand dunes.

TIDES AND CURRENTS

Importance as Related to Sewage Disposal

The elevations and the rise and fall of the tides, and the characteristics of the tidal currents are natural conditions which markedly influence the problems of sewerage and sewage disposal. Their importance was recognized in the Report of 1899 and the Preliminary Report. Further studies have been made and careful consideration has been given to these conditions during this investigation.

Tides

The relation of various tidal planes is shown diagrammatically on Plate 17. It appears that the range of tide between mean lower low water and mean higher high water is 5.56 feet. The mean tidal range is 3.93 feet. The greatest observed range has been 10.5 feet, and that for any one day 10 feet. The average tidal cycle at Fort Point, now designated Golden Gate in the Tide Tables of the United States Coast and Geodetic Survey, is 12 hours and 25 minutes equivalent to 1.93 cycles for 24 hours.

A typical sequence of the rising and falling tides is illustrated diagrammatically by dash lines on Diagram 12, Plate 17. The plotted heights of tide are those predicted in the United States Coast and Geodetic Survey "Tide Tables" for July 25, and 26, 1934. On July 26, the moon was full and in perigee and the tides therefore were greater than the average.

The range between predicted lower low water and higher high water on July 26 was a little more than 8 feet.

Tidal Currents.

The channel tidal currents in Golden Gate Strait are very swift. The shore currents are swift also in the vicinity of the northern sewer outlets, but considerably slower than those in the channel. Plate 17, Diagram 12, shows by solid lines a typical sequence of variation in tidal currents and velocities.

There is also at times a large land water runoff coming principally from Sacramento and San Joaquin Rivers through San Pablo Strait and North San Francisco Bay. On this account, at such times, ebb tides are stronger than flood tides.

Tidal Current Charts for San Francisco Bay published by the United States Coast and Geodetic Survey, as Serial No. 484 and reproduced on Plate 17, show the direction and strength of current each hour at times of tropic tides, i.e., at the moon's maximum declination from the equator, or about every 27 days. From these charts and the current tables it is possible to predict the strength of the tide at various places off the San Francisco shore. While there are days when the tidal currents are swift at the location of each of the outlets considered, there are also days when the currents are moderate.

The direction and velocity of tidal currents at North Point, the Marina, Baker's Beach, and Mile Rock, at

various distances from shore and under various conditions of tide, were determined by a comprehensive series of float observations conducted during the period August 22, - October 9, 1934. The results are presented in a series of charts on Plates 18 - 27, and in summarized form on Plate 28.

A drawing and a photograph showing the types of floats employed are presented on Plates 29 and 30, respectively.

Numerous bottle floats were liberated at the several points in question, and the places were noted where they were subsequently found. The history of the release of these floats and a chart showing their travel are presented on Plates 31 and 32.

The Tidal Prism and Movement through Golden Gate Strait.

Recent information concerning the area and tidal prism of San Francisco Bay is to be found in the Report on Salt Water Barrier by Walker R. Young, Engineer, United States Bureau of Reclamation, published in 1929 as Bulletin No. 22, State of California, Department of Public Works, Division of Water Resources, pages 41, 302-303. From that source the following figures have been taken:

The total water surface of the bays and delta channels at mean high tide, including the larger sloughs, is 541 square miles.

There are about 62,000 square miles of drainage area tributary to Golden Gate Strait, of which the drainage area of the Great Central Valley is 58,000 square miles.

Calculations of tidal prisms for four tidal cycles

beginning at 6:48 P.M., July 6, and ending at 8:00 P.M., July 7, 1925, were made. The volumes considered were those between water surfaces at successive slack water periods. At that date the volume of upland flow was inconsiderable. The area tributary to Golden Gate Strait was estimated to vary between 310,000 and 390,000 acres, the mean depth to range between 2.50 and 6.17 feet, and the tidal prism to be between 700,000 and 2,300,000 acre-feet.

For San Francisco Bay proper the averages of the estimated area and tidal prism values, for both flood and ebb tide conditions, are respectively 200,000 acres and 1,000,000 acre feet, the latter figure being equivalent to 320,000,000,000 gallons or approximately 500,000 cubic feet per second flowing for 24 hours.

For the entire tidal area of the bay and river system tributary to Golden Gate Strait, the averages of estimated area and tidal prism values, for both flood and ebb conditions, are respectively 350,000 acres and 1,500,000 acre-feet, equivalent to 480,000,000,000 gallons or approximately 750,000 second-feet flowing for 24 hours.

In the general case the ebb tide prism should be equal to the flood tide prism plus the yield of tributary streams and minus evaporation. San Francisco Bay proper has a relatively small drainage area directly contributing to it. For the dates in question the calculated tidal prisms for both flood and ebb tides are the same for the entire bay and river system. For San Francisco Bay proper the prism for ebb tide

was calculated to be actually somewhat smaller than for flood tide. The inference is that evaporation was equal to the upland flow when spread over the entire bay and river tidal system but slightly greater than the direct upland contribution to San Francisco Bay proper when taken by itself.

USE OF SHORES AND BEACHES

Utilizable Beaches

Plate 33 has been prepared to show the locations, general extent, and availability of the many beaches along the east, north, and west shores of the City, and their relation to the outlets for sewage, storm sewage, and storm water.

Some of these beaches are relatively large and readily accessible and one in particular, that extending in an uninterrupted stretch for 5 miles south from the Cliff House, is truly magnificent. In its northerly portion it is flanked by the Esplanade and Great Highway and has become famous as one of the great recreational beaches of the region.

Period of Use

These beaches are places of resort on all pleasant days throughout the year, but naturally more particularly during the warmer season. In this report that period has been assumed to comprise the seven months from April to October, inclusive. It is believed that swimming in the shore waters in this region is largely confined to this period.

Types and Extent of Use.

The shore waters and the beaches and other attractive shores are used for many recreational purposes, including swimming and wading, fishing, boating, sunbathing, and picnicking. There are no available statistics which show the numbers of persons utilizing any or all of these beaches, shores, and shore waters, or which define the periods when such use is made of these recreational opportunities. However, it may be stated that enormous numbers of persons on occasion visit the Ocean beach south of the Cliff House, the Yacht Harbor at the Marina, and Aquatic Park, and indulge in all of the recreational activities listed above.

The sandy beaches in numerous coves along the north shore afford some of the best natural salt water bathing opportunities to be found in the San Francisco Bay Region. It is understood that the dangerous undertow encountered on the Ocean shore does not exist here, or at any rate to the same extent. The water is said to be warmer and the exposure to wind less. These beaches are becoming increasingly popular for bathing. The main objection at present is the serious contamination of the water and the large amount of sewage litter found on the beaches. There can be no doubt that the natural beauties and advantages of these shores should be capitalized by the elimination of the sources of contamination, the provision of bathing facilities, and in other ways.

POPULATION

Grunsky's Prediction

The late C. E. Grunsky, in his report of 1899, presented a population curve showing estimated growth to the year 1960. Concerning the curve he made the following statement:

> "It is proper to say that this curve indicates a future population somewhat in excess of that which a careful student would predict and that this is intentional; it being desirable for the study now being made, to know what population is not likely to be exceeded."

On Plate 34 Grunsky's curve is reproduced, together with the curve of actual population to date, showing remarkable parallelism of the two curves where both the forecasted and actually enumerated populations are available. Grunsky's predicted maximum population for 1960 was 1,100,000.

Present Difficulties of Prediction.

Population predictions, difficult under normal conditions, become well-nigh impossible under abnormal conditions such as exist at present. In view of the uncertainty as to the effect of such factors as the present business depression, the construction of the San Francisco-Oakland and Golden Gate bridges, and plans for rapid transit, the prediction of future growth with any assurance borders on temerity. Grunsky's curve still constitutes as reliable an estimate of maximum future population as can be made and therefore it has been adopted.

Distribution of Total Population Among Sewerage Districts.

In order to have a basis for design of outfalls and treatment plants for individual sewer districts, it is necessary to distribute the estimated total growth among the several districts. The City Engineer has made such a study using the following method: The city is divided into twelve Assembly districts, the population of which is known for 1920 and 1930. From the zoning maps the acreages for the different classifications in each district were determined and population densities per acre, based on judgment and past census figures, were adopted such that the total population would approximate 1,100,000. The densities per acre for first residential districts ranged from 30 to 40, for second residential from 50 to 100, for commercial from 20 to 120, for light industrial from 10 to 40, and for heavy industrial from 10 to 20. As a check on this method a survey of vacant lots was made from the insurance maps of three of the twelve Assembly districts. The population of each of the three districts was determined by assuming a future density equal to the present density of the built-up portions and eliminating areas judged unlikely to be developed prior to 1960. A possible tendency toward a changed type of residential structure in the future was taken into consideration. As further checks, comparisons were made with the results of a survey of the Sunset District made by the Board of Education in 1931 and with the predictions of other engineers and organizations.

The future growth by Assembly districts was then re-

distributed on the basis of area and judgment to convert it into growth by sewerage districts. These figures have been used in the design as approximations of populations not likely to be exceeded.

EXISTING SEWERAGE DISTRICTS AND SYSTEMS

Division into Districts

The topography of the city naturally suggests gravity flow of sewage from the main ridge eastward to the bay and westward to the ocean. As the eastern and older portion of the city developed, independent sewerage systems were added with convenient outlets into the bay, until there are now 19 outlets for sewage along the eastern shore. The northern and newer portion of the city west of Fort Mason has been sewered with two systems having two outlets on the north shore.

The sewage of most of the western portion of the city is carried northward by means of a tunnel along the line of Forty eighth Avenue, through the topographic barrier and discharged at the shore. A small area in the southwest corner of the city has its sewage outlet into the ocean at that point.

With one exception, the combined system has been used throughout the city; in other words, sewage and storm water are combined. In one small area near the foot of Market Street separate systems have been constructed; in other words, one for sewage and one for storm water. Diversion structures have been provided at certain points to intercept the sewage. Overflow structures also have been provided to by-pass excess storm sewage. Plate 35 shows the existing sewerage districts

and the main trunk sewers with their diversion and overflow structures.

Southeast Sewerage District

The Southeast sewerage district comprises an area of 5325 acres, about one-sixth of the area of the city, and it had a population of 55,100 in 1930, about one-twelfth of the population of the city. The zoned area is 34 per cent residential, 5 per cent commercial, and 61 per cent industrial. The sewage from this area is discharged into the bay through eighteen outlets. The following tabulation gives information concerning these outlets in consecutive order from the south city limit to Brannan Street.

Location of Outlet	Number of Outlets	Area in Acres	Population in 1930
Visitacion Valley (China Point)	1	850	4000
Yosemite Avenue	1	335	2400
Palou Avenue	1	1010	7000
Evans Avenue (Hunter's Point)	1	325	5000
Islais Creek Channel	4	1570	22500
Twenty-fourth Street	1	310	800
Seventeenth Street	1	50	500
The Channel	6	470	2000
King Street	1	25	300
Brannan Street	1	380	10600
TOTAL	18	5325	55100

North Point Sewerage District

The principal commercial and industrial, and the old residential portions of the city constitute the North Point sewerage district. Zoning ratios are as follows: 64 per cent residential, 14 per cent commercial, and 22 per cent industrial. All the territory east of the divide is included in the North Point district, with the exception of that already described as in the Southeast district. The North Point district embraces 9,060 acres, about one-third of the area of the city, and had a population in 1930 of 386,300, or about two-thirds of the population of the city. At various locations along the North Point main there are diversion structures to intercept the sewage flow. Overflow structures have been provided to by-pass excess storm sewage into the bay or the channels. The locations of these diversions and overflows are shown on Plate 35.

Between Market and Howard Streets east of Third Street, and between Howard and Harrison Streets east of Fremont Street, is a small territory having separate systems for sewage and storm water. The sewage is pumped into the North Point main. The storm water together with a portion of the excess storm sewage from the North Point main sewer is discharged at the foot of Howard Street.

North of Howard Street there are sewers in Commercial and Jackson Streets which carry storm sewage overflows to an outlet on Jackson Street south of Pier 3. On Greenwich Street there is a similar outlet between Piers 23 and 25.

The main outlet of the North Point trunk sewer is near the intersection of Beach Street and Grant Avenue through the bulkhead into the inner end of the slip between Piers 37 and 39. All the dry weather sewage of the district and a portion of the storm sewage are conveyed to this point.

The sewage of the Beach Street sewer is discharged into the North Point sewer and the excess storm sewage through an independent outlet into the slip between Piers 37 and 39.

Marina Sewerage District

The Marina sewerage district is roughly rectangular in shape, one and one-half miles in length, east to west, and one mile in width, north to south. The eastern boundary runs from the southeast corner of Fort Mason southeast to Russian Hill and follows the ridge southeasterly to Jones and Clay Streets. The south boundary follows the ridge through Lafayette Park and Alta Plaza to a point near the southeast corner of the Presidio, thence southwest and west six blocks to include a strip about three blocks wide on the south side of the Presidio. The principal western boundary is the Presidio. The northern boundary is Golden Gate Strait. The eastern and southern boundaries range from 200 to 300 feet in elevation and the slope of the district toward the north is very steep for about half the distance and gentle for the remainder of the distance to the shore.

Fort Mason lies just inside the northeast corner of the district. There are two blocks, not yet filled in, of

light industrial area to the west. The Yacht Harbor and the club house grounds occupy the northwest corner. A wide lawn to the east affords an unobstructed view of the Strait. Extension of the Yacht Harbor easterly is planned.

The total area of this district, exclusive of parks and playgrounds, is 1043 acres and the 1930 population was 61,000. This territory has had a rapid growth during the last fifteen years and only about one-eighth of the area remains unoccupied. It is a high class residential district with numerous fine apartment houses. The zoned area, constituting 88 per cent of the whole, is 88 per cent residential, 8 per cent commercial, and 4 per cent industrial. It is anticipated that the population of this district will increase to 70,000 by 1960 after which little further growth is to be expected.

There are sewer outlets on Baker, Pierce, and Laguna Streets, all discharging directly at the shore. However, the sewage flow is diverted from the Baker and Laguna Street mains to the Pierce Street main while all three are utilized to carry the storm sewage. The steep slopes in the southern half of the area result in high velocities and rapid concentration of storm flow.

Baker's Beach Sewerage District

The Baker's Beach district is roughly rectangular in shape, two and one-quarter miles long, east to west, and one mile wide between the Presidio on the north and Golden Gate Park on the south. The eastern boundary is the ridge, with elevations of 300 to 400 feet above sea level, running through

Laurel Hill, Calvary, and Masonic Cemeteries. The western boundary is partly the ridge with elevation of 200 to 300 feet above sea level running northwest from Twenty-sixth Avenue and Fulton Street to Thirty-eighth Avenue and Clement Street, and partly Lincoln Park. The northern boundary is the Presidio and a short stretch of the Strait shore. The total area is 1425 acres and the population in 1930 was 66,500. The general drainage of this district is toward Lobos Creek which forms the southwestern boundary of the Presidio.

The northern section of this district occupies a bluff overlooking the Strait and contains some of the finest homes in the city. The zoned area, constituting 97 per cent of the whole, is 90 per cent residential and 10 per cent commercial. This territory increased in population 50 per cent during the decade 1920 to 1930 and it is estimated that by 1960 it may have a further increase of 45 per cent above the present population.

The outlet for the sewage of this district is an 18-inch cast iron pipe extending 800 feet into the Strait a short distance west of Lobos Creek. This line is broken in a number of places, allowing most of the sewage to be discharged near the shore. Ordinary storm sewage flows are discharged through a relief outlet at the shore and excessive flows through a relief outlet into Lobos Creek a short distance inland. The slopes of the entire area are steep causing a concentration of storm runoff in a very short period of time.

Mile Rock Sewerage District

The Mile Rock sewerage district embraces three rather distinct territories in the western portion of the city. The West Richmond District includes the area between the ridge described as the western boundary of the Baker's Beach sewerage district and the Ocean and between Fort Miley and Golden Gate Park. This area averages one mile long, east to west, and three-quarters of a mile wide, north to south. The Sunset District includes the area between the main ridge line through the city and the Ocean, and between Golden Gate Park and the old Rancho de la Merced. This area averages three miles long, east to west, and two and one-quarter miles wide, north to south. A third territory from which sewage is diverted includes the area between the main ridge line through the city and the eastern boundary of the old Rancho de la Merced. This area averages one and two-thirds miles long, north to south, and one mile wide, east to west.

The total area within this district is 5400 acres and the population in 1930 was 79,000. The population increased 85 per cent during the decade 1920 to 1930. This is the residential area most available for future development since less than one-third of the area is now built up. The zoned area, constituting 95 per cent of the whole, is zoned 91 per cent residential and 9 per cent commercial.

The general direction of drainage in the West Richmond District is southward toward the main trunk sewer in Fulton Street. Most of the drainage of the Sunset District is northward toward a main trunk sewer in Lincoln Way and the

rest drains westward toward trunk mains near the western boundary of the District. The sewers from the territory east of the old Rancho de la Merced cross the Rancho land, now used mostly for golf courses, and connect with the Sunset District system. The main sewer for the entire Mile Rock District follows the line of Forty-eighth Avenue across Golden Gate Park, passes through the ridge by means of a tunnel 6000 feet long, and discharges at the shore about one-third of a mile west of Land's End opposite Mile Rock light-house.

Much of the Sunset District is a development of sand dunes and the pervious soil may be expected to permit the rapid percolation of rainfall and thus decrease the amount of storm runoff to be carried by the sewers.

PROPOSED SEWERAGE DISTRICTS AND SYSTEMS

General Statement

The need for the expansion of the scope of the report to cover the various districts of the city has been discussed. The future proposed districts are shown on Plate 36. This map shows five major sewerage districts covering the entire city and including the communities of Colma and Daly City in San Mateo County. It is to be noted that a considerable area now discharging into the Bay through separate outlets in the southeastern part of the city will in the future discharge at North Point. The distribution of the 1930 population in the existing districts and in the proposed sewerage districts at the year 1960 is shown in the following table:

Sewerage District	1930 Census Population of Existing District	1960 Estimated Population of Proposed District
Southeast		
Visitacion Valley	4,000	19,000
Hunter's Point	12,000	36,000
Islais Creek to Brannan Street	25,700	------ *
North Point	386,300	625,000
Marina Sub-district	61,000	70,000
Baker's Beach Sub-district	66,500	96,000
Mile Rock	79,000	224,000
Southwest	------	30,000 **
TOTAL	634,500	1,100,000

* Included in North Point
** Exclusive of San Mateo County communities and areas

The program of treatment and disposal recommended by the Board proposes that ultimately the number of outlets for treated sewage will be reduced to four, situated as follows;

1. At China Point, for the flow from Visitacion Valley;
2. At Hunter's Point, for the flow from the area between Visitacion Valley and the North Point sewerage district as ultimately constituted;
3. At North Point, for the flow from the North Point district, including the Marina sub-district;
4. At Mile Rock trunk sewer outlet, for the flow from the Mile Rock Sewerage district, including the Baker's Beach and possibly the Southwest districts.

It is possible that the sewage from the Southwest sewerage district, after appropriate treatment, however, will continue to be discharged through the Vista Grande outlet situated on the west coast opposite the southerly portion of the United States Military Reserve, if the flow is not combined with that of the Mile Rock sewerage district.

The future development of the sewerage systems in the

south-eastern portion of the city may make it desirable to combine the proposed China Point and Hunter's Point outlets.

It should be pointed out that it will be necessary to retain most of the existing outlets and possibly provide some additional ones, for storm overflow discharges.

QUANTITIES OF SEWAGE AND STORM SEWAGE TO BE TREATED

Basis of Design

The volume of sewage is largely determined by the amount of water consumption. The cool summer climate and the absence of spacious yards result in a low average water consumption. During the last 15 years the average daily per capita consumption has fluctuated between 70 and 80 gallons.

Delays incident to authorization of funds for field studies prevented long-continued and accurate measurements of flow prior to the rainy season. However, a number of measurements covering the 24 hours of the day on different days of the week have been made and have furnished a valuable aid to judgment in determining the quantity of sewage for which provision should be made in treatment and disposal works. The results of these measurements are shown on Plates 37 - 39.

The general use of combined sewers to carry both sewage and storm water introduces complications in planning the sewage disposal works. A runoff of 0.02 inch in depth in an

hour will cause a greater rate of flow of storm water in the sewer than the average rate of flow of sewage from an equal area. Obviously, provision can be made in the disposal works for only a portion of the storm water, if prohibitive costs are to be avoided.

The Board has concluded that the practical limit in the volume of runoff to be provided for in the sewage disposal works for any district is 0.02 inch per hour in addition to the average rate of sewage flow. At times when the rate of sewage flow is less than the average, a greater volume of storm runoff can be accommodated. Provision for this quantity will prevent storm discharges at the shore from many of the lighter rains and will reduce the period of discharge of some of the more intense rains. Quantities in excess of those provided for will require discharge of the excess through overflow structures. Reasons for departure from this specific quantity of 0.02 inch per hour for individual districts will be noted in the later discussions.

THE SEWAGE DISPOSAL PROBLEM

Existing Conditions.

The general plan now in use provides for the discharge of the sewage at or near the shore line. Some sewage continues to be discharged into open channels through which it flows to the shore waters, as for example Islais Creek. The only attempt at offshore discharge is at Baker's Beach where the purpose has become frustrated by breaks in the subaqueous outlet pipe.

There are three direct unfavorable results of this practice. One of the most repulsive and in fact dangerous, because of the opportunity for infection of recreationists who frequent the beaches, is the stranding of floating sewage matter upon the beaches. While a large proportion of such materials is carried away by the currents, nevertheless large quantities are driven ashore and become stranded as the tide recedes.

All sewage contains bacteria, some of which may be pathogenic or disease-causative. That the shore waters in many places are seriously polluted is obvious from an inspection of the waters and shores in the vicinity of the sewer outlets.

Samples of shore waters taken weekly during the period February 6, 1933 - February 7, 1934, at 18 stations more or less uniformly spaced along the north and west shores of the city were analyzed to determine the quantitative presence of organisms of the B. coli group. These organisms are typical of sewage and demonstrate contamination thereby. They serve, furthermore, to indicate potential infection. The results

are shown on Plate 40.

Serious bacterial contamination was demonstrated at all points, particularly along the north shore eastward from Point Lobos. Throughout that section the studies have shown average numbers of B. coli as follows:

in excess of	1	per	cc.,	99%	of	the	time.
" " "	10	"	"	87%	"	"	"
" " "	100	"	"	57%	"	"	"
" " "	1000	"	"	40%	"	"	"

South of Point Lobos, along the ocean shore, the average numbers of B. coli were:

in excess of	1	per	cc.,	76%	of	the	time.
" " "	10	"	"	30%	"	"	"
" " "	100	"	"	9%	"	"	"
" " "	1000	"	"	5%	"	"	"

In two localities, namely along Baker's Beach and Crissy Field, at the extreme limits of the Presidio, respectively, the most serious degree of contamination was found. Here the numbers of B. coli were:

in excess of	10	per	cc.,	100%	of	the	time.
" " "	100	"	"	87%	"	"	"
" " "	1000	"	"	72%	"	"	"

Further tests were made during this investigation. They confirmed those just described in indicating the points of gross bacterial contamination. For example, about half-ebb tide on September 24, 1934, it appears that the sewage from the North Point outlet at Pier 37 was being carried westward in the shore waters and caused a high degree of contamination at least as far as the Marina. See Plate 41. Corresponding results were obtained between Mile Rock outlet and Baker's Beach. See Plate 42.

In explanation of the insanitary conditions found to exist, it may be stated that, generally speaking, the tidal currents in and out of Golden Gate Strait are parallel to the shore line and that the strength or velocity of the current increases with the distance from shore. Thus it becomes apparent that sewage discharged at the shore tends to follow the shore rather than to overcome the swifter currents and flow out into the channel. Hence the currents tend to carry the sewage along shore and to prevent it from becoming diffused in the great volume of clean water relatively near at hand.

The travel of the sewage carried by the currents, of course, is first one way and then the other, reversing its direction with each change in the direction of the tidal current.

At times of relatively slack water, which are brief at San Francisco, there may be some slight opportunity for sedimentation of the finer organic sewage solids, but conditions are such that if the coarser solids are removed, little deposition is likely to take place except in slips, as between Piers 37 and 39, and other areas protected from the stronger currents. Such deposits, if any, which may be formed temporarily offshore undoubtedly would be quickly scoured away by succeeding swift tidal currents.

The wind has an important influence upon shore pollution, especially by floating materials and suspended particles of sewage origin. An inshore wind, even though having an

intensity of only 10 - 20 miles an hour, will set up on-shore surface currents. For example, a wind velocity of 10 miles per hour will induce a surface current having a velocity of about 30 feet per minute and a 20-mile wind a resulting surface current of approximately 40 feet per minute. At times of relatively slack water, particularly, such induced currents may carry floating and suspended materials to the shore waters and beaches. At other times also, the resultant of the wind-driven surface current and the tidal current will carry such objects toward the shore.

Dilution as a Final Agent in Disposal

With such an abundant supply of diluting water so readily available as shown in the discussion of tides and tidal currents, it is obvious that its value for this purpose should be utilized as fully as is economically possible.

The specific gravity of sea water is greater than that of sewage, which is principally land or fresh water; hence, the lighter sewage will rise to the surface if discharged under sea water. In traveling through the sea water diffusion takes place.

As the depth at which the sewage is discharged beneath the surface of the sea increases, the amount of diffusion which takes place before it reaches the surface increases. Therefore, the greater the depth at which the sewage is discharged, the greater will be its corresponding initial dilution.

A swiftly moving current sweeping past a submerged outlet imparts a horizontal component to the path of the relatively light rising sewage and thus increases the length of travel to the surface. This obviously increases the dilution at the surface and improves the effectiveness of the outlet in this respect.

It has long been recognized that dilution is improved by discharging a definite quantity of sewage through many outlets rather than through a single outlet. To secure the greatest advantage of a diffusion area, the outlets should be placed far enough apart to minimize or avoid interference between the rising streams of sewage from adjacent outlets.

In still water the relatively light sewage will overlie the heavier sea water in a definite stratum at the surface. Agitation of the surface by tidal and wind currents will tend to break up this stratification and increase the dilution.

In considering the travel of sewage from a submerged outlet, wind-induced, as well as tidal currents, must be taken into account, as already suggested.

Under the local conditions, with a view to utilize most advantageously in so far as is reasonably practicable, the diluting capacity of the available waters, it will be advisable to discharge the sewage effluent at any dispersion area through a well designed system of nozzles. Outlet pipes, if provided at North Point and at Mile Rock, should be carried to water at least 50 feet below mean lower low water.

Sewage effluent, if discharged in this manner, will be diffused effectively during its passage to the surface and will be carried away by the tidal currents. The finely divided and dissolved sewage substances thus liberated will furnish food for fish and smaller living organisms including the bacteria present in such waters. In this manner the organic substances will become oxidized, innocuous, and harmless.

Required Degree of Treatment of the Sewage

If financially feasible to provide the necessary outlet pipes to suitably-located diffusion areas, relatively little treatment of the sewage will be required as compared with that necessary at places less advantageously situated. The treatment necessary will be only that required to remove from the sewage before its discharge as much as practicable;

(1) of the floating matter which causes unsightly and offensive sewage and sleek fields and fouling of shores,

(2) of the coarse suspended solids which pollute the shore waters and litter the beaches, and

(3) of the bacterial content when and as found necessary to maintain the shore waters in safe condition for bathing, wading, and other recreational uses.

TREATMENT AND DISPOSAL OF SEWAGE OF THE SOUTHEAST SEWERAGE DISTRICT

General Program

The City proposes to reconstruct, at some time in the future, the sewerage system of the Southeast district to concentrate the discharge of sewage into the Bay at two outlets. The following is a brief outline of the plan. The area and population figures given below do not take into consideration present tide lands eventually to be filled in, to the south and north of Hunter's Point.

The sewage from Visitacion Valley with an area of 850 acres, and an estimated population of 19,000 in 1960, will be collected and discharged into the Bay at a single point near the present outlet, after such treatment as it may require.

The area now served by the Yosemite Avenue outlet will be sewered with a new separate system, the sewage from which will be pumped into the Hunter's Point main. The existing system with the present outlet will be utilized for storm water.

The sewage and storm waters now discharged at Palou Avenue will be carried by gravity through a tunnel 3,000 feet long under the line of Fitch Street to connect with the proposed extension of the Hunter's Point main.

The Hunter's Point main will be extended along Evans Avenue to the Bay where a treatment plant may be built south of the dry docks and from which an outlet pipe may be extended into the Bay. This plan will provide for the discharge off Hunter's Point, after such treatment as may be required, of the sewage from Yosemite Avenue district, and the sewage and storm sewage from the Palou Avenue and Hunter's Point districts, and

also from a part of the present area draining from the south into Islais Creek Channel.

The total area tributary to the future Hunter's Point outlet will be 2200 acres with an estimated population of 66,000 in 1960. Float studies made by C. E. Grunsky in 1899 led him to consider Hunter's Point an advantageous location for an outfall because of favorable depth and currents.

For the remainder of the present Southeast district, it is proposed to construct a separate sewerage system and to pump the sewage into the North Point main. This portion of the district extends from the future Hunter's Point district north to Howard Street and comprises an area of 2275 acres with an expected population of 45,000 in 1960.

The projected plan would eliminate the discharge of all sewage into Islais Creek Channel and The Channel, leaving only storm water to be discharged from the existing outlets. The net result of the proposed development will be to prevent discharge of sewage into the Bay south of Market Street except at Hunter's Point and Visitacion Valley where outlet conduits can be built to provide for discharging the sewage, after it shall have been treated as found to be necessary.

TREATMENT AND DISPOSAL OF THE SEWAGE OF THE NORTH POINT AND MARINA SEWERAGE DISTRICTS

General Program

The plan recommended herein for disposal of the sewage from the North Point and Marina sewerage districts provides for its dischargein deep water well offshore, after the coarser floating and suspended sewage solids, together with oil

and grease, shall have been removed in order that wind-driven surface currents may not carry such matter to the shore waters and that freedom from deposits may be assured.

Float tests made September 5, 23, and 24, 1934, clearly indicate that treated sewage, discharged as proposed, will be carried away without danger of polluting the shore waters; whereas similar tests made August 31 and October 9, 1934, just as clearly indicate that if the sewage were to be discharged at the pier head, the shore waters would be polluted.

Assumed Basic Data

The assumed data upon which preliminary designs and estimates of cost for the treatment and disposal of the sewage are based, are as follows:

Basic Quantitative Design Data for the North Point and Marina Sewerage Districts

Populations	Year 1930	Year 1960
North Point	413,500 (a)	625,000
Marina (b)	70,000	80,000

(a) Actually contributory 386,300

(b) Including the Presidio and Fort Mason

Estimated Sewage Flow Quantities

North Point,	average	rate,	g.c.d.	-	100	
Marina,	"	"	"	-	115	
North Point,	maximum	"	"	-	150	
Marina,	"	"	"	-	230	
North Point,	ultimate	average	rate, m.g.d.	-	69	
Marina	"	"	"	" -	9	
North Point,	"	maximum	"	" -	93	*
Marina,	"	"	"	" -	23	(c)*

* These volumes combined for plant and outlet pipe design at 120 m.g.d.
(c) Including some storm water.

Sewage from Marina Sewerage District

As described later, the sewage from the Marina sewerage district will be conveyed to the North Point treatment plant, thus increasing the ultimate average sewage discharge at this point about 15 per cent. Because of the allowance for some storm water from the Marina district but none from the North Point district, the increase at times of maximum rate of flow will be about 25 per cent in the volume to be treated and discharged through the outlet pipe.

Storm flows originating in the North Point sewerage district, in excess of the capacity of the plant, will be diverted through the storm overflows at Howard Street, at Jackson and Commercial Streets, and at Greenwich Street. It should be pointed out, however, that on the average the treatment plant and outlet pipe will have an excess capacity of 49 million gallons a day, equivalent to 69 per cent of the average sewage flow, available for caring for an excess flow of storm sewage under conditions assumed to exist in 1960, and, prior to that time, considerably more.

Submerged Outlet Pipe

A submerged outlet pipe will carry the effluent from the North Point sewage treatment plant into the Bay. The pipe may be placed under Pier 37 or in the slip between Piers 37 and 39. The latter location appears preferable. Its internal diameter will be about 72 inches for a maximum rate of flow of 120 million gallons a day.

The United States Army Engineers' requirements at North Point are stated to be that "the pipe beyond the pier head line and all protruding parts such as nozzles, must be 50 feet below mean lower low water."

Plate 43 shows the profiles of the bottom of the bay on alternate lines for the proposed outlet pipe: one beneath and beyond Pier 37 parallel to its center line; the other in and beyond the slip between Piers 37 and 39. On these lines the soundings are shown to points approximately 2,500 feet out from the bulkhead line.

It is proposed to extend the outlet pipe approximately 2000 feet from the bulkhead line where the depth of water is 60 feet below mean lower low water. This will provide for the required depth of 50 feet over the highest obstruction due to backfill around the pipe and to the diffusing nozzles. It is assumed that a trench will be dredged from the shore so that the top of the pipe line will be at least 50 feet below mean lower low water.

Soundings shown on the United States Coast and Geodetic Survey chart indicate hard sand about 3,000 feet to the east of the location of this pipe and broken shells about 1,000 feet to the west.

While the tidal currents in this vicinity are swift, there does not appear to be sufficient ground swell to prevent the use of floating equipment in building this structure. It, therefore, is planned to dredge a trench, place the pipe, and backfill over the pipe, all from floating equipment.

Beginning at a point about 1,800 feet offshore, the pipe will be divided into branching lines of gradually reducing sizes. The sewage will be discharged through a number of nozzles placed in these lines. The distributing pipes will be protected to prevent undercutting by the current.

Before proceeding with the detailed design of this project, borings should be made along the line of the proposed outlet pipe in order to determine the character of the material in which the pipe will be laid and the need, if any, for supporting the pipe on piles. Such borings will disclose any probability of encountering rock at the depth of the proposed excavation.

The estimated construction cost of this outlet pipe, including engineering and contingencies, is $400,000.

Site for Pumping Station and Treatment Plant

While the tentative layout for a pumping station and treatment plant is shown on Plate 44 as utilizing Blocks 34 and 35, other land in the vicinity would be suitable.

Even though funds are not available for constructing the pumping station and treatment plant, it would be advisable to purchase a site for these works as soon as possible.

Pumping Station

The sewers which converge to North Point discharge by gravity. When provision is made for the treatment of the sewage as herein recommended and for the discharge of the effluent through a submerged pipe line, about 2,000 feet from the bulkhead line, it will be necessary to pump the sewage. Accordingly, a pumping station has been planned with multiple pumping units suitable for pumping the variable flow in the most economical manner. A tentative layout of the pumping station and administration building, made for cost estimating purposes, is shown on Plate 44.

Treatment Plant

The sewage will be passed through two sets of bar screens or racks, one manually and one mechanically cleaned, and will then flow through grit chambers wherein coarse and heavy mineral detritus will be deposited. From the grit chambers the sewage will pass through Venturi measuring flumes whereby its volume will be indicated and recorded.

The sewage leaving the Venturi flumes will pass through aeration channels in which it will be aerated for a period of at least five minutes at the design capacity of 120 million gallons a day. This aeration is to be provided as an aid to the separation of the grease from the sewage.

From the aeration channels the sewage will pass into skimming basins through which it will flow slowly and be detained for a period of at least ten minutes to permit oil and grease to rise to the surface from which it will be skimmed more or less continuously. The basins will be equipped

with moving skimmers which will collect the oil and grease and deliver this material to a suitable outlet whence it will be delivered to the incinerator. Any solids which may settle in these tanks will be collected by traveling scrapers and this sludge will be pumped into the outflowing sewage to be passed through the fine screens later described.

The effluent from the skimming basins will flow to a battery of fine screens having slots about 1/16-inch by 2-inches in size. By means of these screens the coarser suspended and floating solids will be removed. From the screens, the sewage will pass to the outlet pipe and be discharged as previously described.

The screenings, skimmings, and grit will be incinerated in a high temperature incinerator which will reduce them to mineral ash, without the escape of objectionable odors.

Provision is made in the pumping station for administrative and laboratory quarters. It is proposed to cover, or house, all sewage treatment structures and make suitable provisions for ventilation.

A provisional layout of the treatment plant and sections through the principal structures are presented on Plate 44.

Estimates of Cost

The construction cost of this project, including engineering and contingencies, is estimated as follows:

Purchase and preparation of site	$600,000
Pumping station and treatment plant, with necessary changes in and connections to existing sewers	1,250,000
Outlet pipe, including diffusion system	400,000
TOTAL	$2,250,000

THE MARINA SEWERAGE PROJECT

Proposed Solution of the Problem

Disposal of the sewage from the Marina district may be accomplished in one of two ways: either by treatment within the district with discharge of the effluent through a suitable outlet pipe extending into Golden Gate Strait, or by pumping the sewage to another outlet outside the district.

Any plan for disposing of the sewage of this district should provide for the ultimate estimated population of 70,000 and, in addition thereto, a population of 10,000 in the Presidio and Fort Mason.

If the sewage from the Marina district should be treated within the district the most logical location topographically for a treatment plant would be somewhere in the flat area bordering the Strait, although less favorable sites exist somewhat back from the shore. A location at the extreme northwest corner of the district would seem most favorable, either just inside Presidio property or just east of Lyon Street in the park. It has not been considered possible to secure permission to utilize Presidio property. Any proposal to construct a treatment plant above ground in the park, even though completely housed and architecturally attractive, would be likely to arouse opposition as an undesirable encroachment upon the park area at its most useful location, as an obstruction to view, and as a possible cause of property depreciation. Even a plant constructed completely underground, involving greater first cost and cost of operation, would eliminate only part of the possible objections.

In the Preliminary Report a surface plant was estimated to cost $470,000 and an underground plant $700,000. To either sum would have to be added the cost of a suitable outlet pipe. The probable objections to such a plant combined with its high cost have led to the recommendation of another solution of this problem.

It has been found practicable to convey the sewage to the North Point district. Topographically the chief obstacle is the high ground occupied by Fort Mason. However, it is possible to utilize the Belt Line Railroad tunnel, placing the pipe at the bottom in one corner, and still maintain the clearances required by the Railroad Commission. Utilizing this tunnel will save pumping over a considerably higher elevation, or constructing another tunnel under Fort Mason. The summit on this line will be at elevation 12, city datum, at the west end of the tunnel. The static lift will be 25 feet. The operating heads will vary from 30 to 70 feet for discharges varying from 1.5 to 23 million gallons a day.

It is important that the sewage from the three outlets serving Fort Mason and the five outlets serving the Presidio should not be discharged at the shore as at present. It can be diverted and conveyed to the Marina system. Permission for such diversion has been included in the proposed agreement with the War Department granting authority to the City to lay the proposed force main in the tunnel through Fort Mason. The City should urge the Federal Government agencies to provide promptly for such diversion of this sewage.

Assumed Basic Data

The assumed data upon which preliminary designs and the estimates of cost of this project have been prepared, are as follows:

Population 1930, including the Presidio and Fort Mason	70,000
" for design, " " "	80,000
Sewage flow, average rate, g.c.d.	115
" " maximum " "	230
" " average, for design, m.g.d.	9.2
" " maximum " " "	18.4
Storm run-off, 0.02 inch per hour from 1043 acres, m.g.d.	13.5
Allowance for design; maximum volume equivalent to average sewage flow plus storm run-off, m.g.d.	22.7
Say, "	23

Characteristics of Sewage

Plate 45 shows the characteristics of the sewage of this district as determined by the analysis of samples collected at a point representing approximately 60 per cent of the total population. The samples were collected hourly on two representative days of the week during the dry season of the year.

Diversion to North Point District

The project recommended includes the following features:

(1) A diversion structure in the Pierce Street sewer, north of Marina Boulevard, with such repairs in that sewer as may be necessary.

(2) A short diversion sewer with suitable control valves leading to a suction well.

(3) An underground pumping station with suction well, pump pit, utility rooms, and equipment comprising principally pump units and appurtenances, piping, switchboard, etc.

(4) A Venturi meter and meter chamber just outside the pumping station.

(5) A 30-inch force main approximately 9600 feet in length in Marina Boulevard to and through the tunnel beneath Fort Mason, thence skirting Aquatic Park and along Jefferson Street and The Embarcadero to a junction with the Beach Street sewer with outlet in the slip between Piers 37 and 39.

This project will obviate the necessity for the construction of a treatment plant in the Marina district with the attendant disadvantages already mentioned, will save considerable cost, thus permitting immediate construction with funds now available, will transfer sewage to a location where less complete treatment will be required in the future, will not appreciably aggravate present conditions at Pier 37 owing to the relatively small volume of sewage added, and will permit its ultimate discharge through the North Point outlet pipe at a more favorable location for disposal as indicated by float studies.

Plate 46 shows a tentative layout of the proposed pumping plant showing inlet and outlet piping arrangements and typical sectional elevations.

Plate 47 has been prepared to show the location of the force main from the pumping station near the Yacht Harbor to a point of connection with the existing Beach Street sewer on The Embarcadero opposite the slip between Piers 37 - 39.

Construction Cost Estimates

The estimated construction cost of this project, including engineering and contingencies, is as follows:

Pumping Station	$120,000
Force main, repairs to existing Pierce Street sewer	132,000
TOTAL	$252,000

TREATMENT AND DISPOSAL OF THE SEWAGE OF THE BAKER'S BEACH, RICHMOND, AND SUNSET DISTRICTS DESIGNATED THE MILE ROCK SEWERAGE DISTRICT.

The Problem of a Treatment Plant Site

At the outset it was assumed that the treatment of sewage from the Baker's Beach district would be conducted at a plant on or in the vicinity of the Presidio and near the mouth of Lobos Creek, as contemplated in the Preliminary Report. The early conclusion of the Board was that the only practicable location for such a plant was inside the Presidio.

A possible location just outside the Presidio is partly occupied by fine homes and adjoins a high-class residential

district. Adjacent to the shore line the slope is steep with perpendicular cliffs dropping to the water's edge. To acquire the requisite area for a plant, to destroy the existing improvements, and to prepare a plant site by constructing retaining walls and by grading, would entail a prohibitive expenditure and make the plant construction from the present bond funds out of the question.

Prior to the appointment of the Board, permission had not been secured by the City from the War Department to make surveys to determine the best location of a plant within the Presidio. In order to secure this permission, if possible, a conference was arranged between the Board and Major General Craig, commanding the Ninth Corps Area, and his staff. At the conclusion of that conference, Major General Craig announced that he would make his decision only after presentation of a plan of the contemplated works together with a description of the proposed method of operation. These were prepared in considerable detail and presented to him. The request was denied.

The action of Major General Craig left only two alternatives. One was to attempt to secure, by Congressional action, permission to proceed with the construction of the proposed works in the Presidio; the other one was to convey the sewage from the Baker's Beach district to some location outside the Lobos Creek drainage area for treatment and disposal. Appeal for Congressional action did not offer immediate or even reasonable likelihood of favorable action and the delay might result in the defeat of the plan for construction of the plant

as a PWA project. The alternative course, therefore, was adopted, and a study was undertaken of the possibility of locating a suitable treatment plant elsewhere to which the sewage from the Baker's Beach district might be carried.

The only other location along the Golden Gate Strait where an area of sufficient size for a plant might be developed was near Land's End. A sewer 6,000 feet long, mostly in tunnel, could carry the sewage by gravity from the Baker's Beach District to this location. A force main could also be constructed thereto from a pumping plant situated at the Mile Rock outlet. Thus, treatment at some future date of the sewage from the Baker's Beach district and the Richmond-Sunset district could be made possible in a single plant, with subsequent disposal through a single outlet pipe.

Superficially, the area showed definite and wide-spread evidence of slides. In order to determine how serious these conditions might be, the Board requested the City to secure the opinion of a geologist. Accordingly Thomas V. Reeves, Geologist, was retained, and he made a careful investigation and rendered a report in which he summarized his conclusions as follows:

> "I consider the site at Land's End, in view of the data now available, as not suited for the proposed plant and tunnels, and recommend that further consideration of this site be dropped, unless definite proof of its fitness is submitted."

His report is reproduced in its entirety in Appendix 2. Pursuant to this advice, the Board abandoned the idea of locating a plant along the shore of the Golden Gate Strait.

The Board next gave consideration to the possibility of conveying the sewage southwesterly to a treatment plant site in or adjacent to Golden Gate Park, being influenced in a measure by the existence within the Park of a plant which treats approximately 600,000 gallons of sewage a day. This plant supplies much needed irrigation water for park use. It is stated that an additional quantity of several million gallons daily could be used advantageously to supply the requirements of the existing vegetation, now suffering seriously from lack of water, humus, and fertilizer. The Board felt that treated sewage effluent could be made available there for irrigation and that digested sludge would furnish a cheap source of humus and nitrogen for the sandy areas of the Park.

The Board of Park Commissioners recognized the value of this possible supply of irrigation water, humus, and fertilizer. The site which was first suggested by the Board of Consulting Sanitary Engineers, near the north end of the Park east of the Forty-seventh Avenue entrance and for which a tentative plan was prepared, did not meet with the approval of the Board of Park Commissioners. An alternative site in the southwest corner of the Park, adjacent to one of the existing irrigation pumping plants of the Park, was suggested by the Park authorities. After examination of this site and submission of a plant lay-out, conferences were held with the Board of Park Commissioners, and the requisite area for the plant was allocated, subject to formal ratification.

Important advantages accrue from the location of a

plant in Golden Gate Park. One of these is that the sewage from the Baker's Beach district and from the West Richmond-Sunset district, can be combined and treated in a single plant. Another is that the location permits the concentration at this place of the major portion of the sewage by gravity flow, it being necessary to pump but a small portion.

THE BAKER'S BEACH SEWERAGE PROJECT.

Diversion to Golden Gate Park Treatment Plant.

To divert the sewage from the Baker's Beach district to Golden Gate Park will require the construction of a tunnel through the hill, a new sewer in Fulton Street, and a connecting sewer from Fulton Street through the Park to the plant.

The principal diversion will be made at the intersection of Lake Street and Twenty-fourth Avenue, from which point a tunnel will extend westward in Lake Street to Twenty-sixth Avenue, thence to the intersection of Thirty-fourth Avenue and Cabrillo Street, thence through Thirty-fourth Avenue to Fulton Street, unless subsequent geological investigation should indicate a more favorable route. At this point, the flow will be discharged into a new gravity sewer in Fulton Street, which will extend westerly to the corner of Forty-sixth Avenue. Here the flow from the Baker's Beach district will join that from the West Richmond district. Thence it will be conveyed to the proposed treatment plant through a new sewer to be built through the Park. See Plate 48.

A small area known as the Seacliff District, in the

northerly part of the district, lies at too low an elevation to permit of a gravity diversion. To serve this area, it will be necessary to build a few small collecting sewers, a pumping station, and a force main. Construction cost estimates provide for a circular pumping station located beneath the street surface in the circle at the extreme northerly end of Twenty-fifth Avenue. See Plate 49.

From the pumping station, it is proposed to build a 12-inch cast iron force main extending southerly in Twenty-fifth Avenue to Lake Street, at which point the force main will discharge into the main diversion tunnel.

Assumed Basic Data for Design.

The assumed data upon which the preliminary designs and estimates of cost of the diversion works have been based are given in the table below. It is proposed to provide for the removal from this district of all sewage and storm runoff up to a maximum rate of flow of 30 million gallons in 24 hours.

Population, 1930	66,500
" for initial design of treatment works	80,000
" ultimate, for design of diversion works	100,000
Sewage flow, average rate, g.c.d.	100
" " maximum " " " "	200
" " ultimate average rate, m.g.d.	10
" " " maximum " " " "	20
Storm runoff, 0.02 inch an hour from 1,500 acres rate m.g.d.	20
Maximum volume for design of diversion works, average flow plus storm runoff, m.g.d.	30

Construction Cost Estimates.

The estimated construction cost of the Baker's Beach diversion works, including allowance for engineering and contingencies, is as follows:

Seacliff sewers, pumping station, and force main	$40,000
Main diversion tunnel and gravity sewers to treatment plant.....	425,000
Total.....	$465,000

THE RICHMOND-SUNSET SEWERAGE PROJECT

Diversion Works.

As previously described, the sewage of the Baker's Beach district will be diverted to a treatment plant to be built in Golden Gate Park. This plant also will treat the sewage of the West Richmond and Sunset Districts and that of the area lying easterly of the old Rancho de la Merced.

Sewage of the West Richmond District west of Forty-sixth Avenue and north of Fulton Street will be pumped at the existing Forty-eighth Avenue and Fulton Street pumping station through a force main in Fulton Street to Forty-sixth Avenue, whence it will flow by gravity through a proposed 36-inch pipe in the Park to the treatment plant.

Sewage of a portion of the Sunset District will be diverted at Lincoln Way and Forty-fifth Avenue and will be conveyed to this treatment plant by gravity through a new 30-inch sewer in the Park. The remainder of the sewage of this

district will be pumped to the plant from the existing trunk sewer at the proposed plant in the Park. The locations of the sewer lines are shown on Plate 48.

Assumed Basic Data

The preliminary designs and cost estimates of the Richmond-Sunset project are based upon assumed data given in the following tabulation. The population tributary to the existing activated sludge plant in the Park is included merely to indicate the total population of the district.

POPULATION AND FLOWS

POPULATIONS

Districts	1930 Population	Adopted for Initial Design	Adopted for Ultimate Design
Baker's Beach	66,500	80,000	100,000
West Richmond-Sunset	79,000	120,000	210,000
Total	145,500	200,000	310,000

SEWAGE FLOW

Baker's Beach	average flow g.c.d.	100
West Richmond-Sunset	" " "	60
Baker's Beach	maximum flow "	200
West Richmond-Sunset	" " "	96
Baker's Beach	average flow m.g.d.	8
West Richmond-Sunset	" " "	7
Total		15
Baker's Beach	maximum flow m.g.d.	16
West Richmond-Sunset	" " "	11.2

STORM SEWAGE FLOW

Baker's Beach	maximum flow m.g.d.	30
West Richmond-Sunset	" " "	25
Total		55

Note: The 1930 population includes that tributary to the activated sludge plant in Golden Gate Park. Design populations do not include that tributary to the activated sludge plant.

Characteristics of Sewage

The characteristics of the sewage of the Baker's Beach District are shown on Plate 50. These were determined by

analyses of samples collected at a point where the contributory population was approximately 90 per cent of the population of the district, or about 60,000 persons. Composite samples were taken hourly through one week in August, 1934, and represent flow conditions similar to those existing when the flow gaugings were made. See Plate 38.

The characteristics of the sewage of the Sunset District are shown on Plate 51. The samples were collected at a point on the Forty-eighth Avenue main trunk sewer just inside the southerly boundary of Golden Gate Park, and represent the contribution from possibly 60,000 persons. These composite samples were taken during two typical days of the week when the flow conditions were not materially different from those which obtained when the flow in this sewer was measured. See Plate 39.

Treatment Plant Site.

The treatment plant site in Golden Gate Park is conveniently situated for serving the district. Topographically, the site is well adapted for a plant of the kind recommended.

Treatment Plant.

The plan for treatment provides for chlorinating the sewage before it enters the plant for the purpose of eliminating any objectionable odors which might escape from the sewage during its passage through the plant.

The sewage will enter the measuring and screening building where the flow will be measured in Venturi flumes

and the volume indicated and recorded by suitable devices.

The sewage will pass from the measuring flumes to bar racks equipped for mechanical raking. Here the coarsest of the floating and suspended matter will be removed and, after maceration, will either be returned to the stream of sewage or be sent directly to the digestion tanks described later.

From the racks the sewage will pass to grit chambers, provided with equipment for mechanical cleaning. Here sand and other similar material will be removed so that they may not form deposits and cause trouble in other structures.

From the grit chambers the sewage will flow through channels where it will be aerated to aid in the flocculation, flotation, and removal of oil and grease.

At or near the outlet of the battery of grease removal channels a connection will be provided and space reserved for structures for any form of treatment which subsequently may be found advantageous, prior to the passage of the aerated sewage to the sedimentation tanks.

The sewage will pass thence to a chamber whence it will be distributed to four sedimentation tanks equipped with sludge scraping and scum skimming mechanisms. A large proportion of the suspended solids will be deposited in these tanks as the sewage passes slowly through them.

The effluent from the sedimentation tanks will be treated with chlorine to kill pathogenic bacteria. It will then either be utilized in the Park or it will flow by gravi-

ty to the Mile Rock trunk sewer through which it will pass and be discharged at the present outlet.

The sludge from the sedimentation tanks will be pumped into gas-tight digestion tanks in which the organic matter will be broken down by biological action. Thus the solids will be rendered inoffensive and greatly reduced in volume. This action is accompanied by the generation of large quantities of inflammable gas which will be utilized, in so far as necessary, for furnishing heat to aid the process of digestion which may be carried on at a temperature of 80° to 90° F., or even higher. There will be a surplus of gas available for power production or any other desired purpose. Any gas not utilized should be burned in order to avoid any possible escape of objectionable odors.

The sludge from the digestion tanks will be treated with ferric chloride or otherwise put into condition suitable for the rapid and economical removal of a large proportion of the water from the solids.

The sludge after being conditioned in this way will be pumped to vacuum filters by means of which much of its contained water will be removed and the solids will be converted into a cake containing a moderate proportion of moisture and suitable for transporting and spreading on the land or composting as may be desired.

An appropriate building will house the laboratory, power plant, vacuum filter plant, post-chlorination equipment, and pumping machinery.

It is recommended that all channels, tanks, and other structures through which the sewage flows be covered or

housed, that all buildings and other structures be designed in a manner to conform to the architectural and other requirements of the Park, and that the treatment plant grounds be graded and planted in a manner which will make the plant an attractive feature of the Park.

A provisional layout of the treatment plant and appurtenances, made for cost estimating purposes is shown on Plate 52.

Disposal of Sludge.

The sludge cake may be used as a top dressing for grassed areas and around shrubbery and plants. The sludge may also be used for building up a considerable depth of soil by spreading in a thick layer and covering with loam, or if loam is not available the sludge can be worked over and weathered until it becomes a suitable top soil. As the sludge is about one-half organic matter and contains a substantial amount of nitrogen, it should be a valuable source of humus and fertilizer. Such dewatered sludge has the advantages, in contrast with manure, of being practically free from weed seeds and of not causing "burning" of grass.

The disposal of the sludge should be planned so that it can be removed from the plant as fast as it comes from the filters and used. If necessary or desirable, however, it can be composted, with or without other materials, for later use.

If the quantity produced exceeds the requirements of

the Park, it may be used on near-by golf courses and other areas.

In view of the character of the soil of the Park and of the publicly-owned golf courses and other areas, it is probable that a considerable quantity of sludge can be used for an indefinite time in the future. Furthermore, there may be a demand for the sludge for use on private grounds. Such disposal will conserve large quantities of humus-forming material and fertilizing ingredients so much needed for the sandy soils of the Park and other areas.

If at any time in the future it shall be found difficult or unreasonably expensive to dispose of the sludge in the manner suggested, it will be practicable to incinerate it at high temperature and thus reduce it to a mineral ash which can be disposed of readily by dumping at any appropriate place.

Disposal of Effluent

It is proposed to furnish to the Park authorities as much of the plant effluent as they desire for irrigation and other purposes. The remainder after treating with chlorine will flow through the Mile Rock trunk sewer to the present outlet a short distance eastward from Point Lobos.

The effectively chlorinated effluent when mixed with sea water will not be likely to endanger the health of persons using the shore waters for recreational purposes, and will not contain coarse floating and suspended matter which will foul the shores and beaches. It is recognized, however, that

when the necessary funds can be made available, it may be advisable to provide either for discharge in deep water well off shore or for more complete treatment before discharge, whichever may prove to be the less expensive or the more advisable.

Studies of the feasibility of constructing an outlet pipe have been made during this investigation. However, because of the lack of borings which it has not been financially possible to make, and because of the uncertainty in regard to the amount of effluent which can be used advantageously in the Park, it is not deemed wise to make any definite recommendation on this problem in this Report.

Estimates of Cost.

The construction cost of this project, including engineering and contingencies, has been estimated as follows:

West Richmond collection works, pumping plant, and force main.....	$12,000
Lincoln Way Diversion structure and gravity line.....	28,000
Richmond-Sunset Treatment Plant including pumping plant.....	543,000
Total	$583,000

Provision for Future.

The Mile Rock sewerage district will be further developed and its population will increase. Therefore a larger plant will be required eventually. The plant now contemplated is laid out in a manner to permit of enlargement without the abandonment of any structures provided at the outset.

TREATMENT AND DISPOSAL OF THE SEWAGE OF THE SOUTHWEST SEWERAGE DISTRICT.

Existing Conditions.

A sewer outlet, designated herein as the Vista Grande outlet, discharges a small but significant quantity of sewage directly upon the beach and thence into the Pacific Ocean approximately 3000 feet north of the City and County line, and slightly more than a mile south of Fleishhacker Pool. The lower end of this sewer is a 4-foot by 7-foot tunnel about 3000 feet in length, designed to carry both sewage and storm water. The contribution to this outlet from San Francisco consists almost entirely of storm water. The contribution of sewage, possibly averaging one million gallons a day, comes from communities in San Mateo County; Colma and Daly City, with possibly some adjacent territory. This sewage produces an extremely foul condition of the beach and pollution of the shore waters in the vicinity of the outfall.

At the present time the sewage from Colma and Daly City is being inadequately treated and, at times at least, discharged in a swampy area within the City of San Francisco. The project as constructed, however, contemplated pumping of the effluent into a wooden flume leading to the Vista Grande outfall.

Sewage Treatment.

Consonant with the recommendations made with respect to the discharge of sewage through the Mile Rock outlet, it is recommended that no inadequately treated sewage be discharged through the Vista Grande outlet. To this end it is advised that negotiations be undertaken immediately with the authorities of Daly City and the adjoining areas to the end that provision be made for eliminating the nuisance now existing, due to the sewage from these areas, either by complete treatment and appropriate disposal of the effluent or by pumping through a force main into the system of sewers in the Sunset District leading to the treatment plant in Golden Gate Park.

Any sewage contributed from the Southwest sewerage district within the city limits should be concentrated at a single suitable point and pumped into a main sewer of the Sunset District tributary to the proposed treatment plant in Golden Gate Park.

RECAPITULATION OF CONSTRUCTION COST ESTIMATES

The estimates of the construction cost of the works, including engineering and contingencies herein proposed are summarized in the table below in two parts; first, those works recommended for immediate construction totaling $1,300,000.00, and second, those recommended for later construction totaling $2,250,000.00

A. Work recommended to be done from present bond funds.

North Point and Marina Sewerage Project.

Marina Pumping Plant and Force Main, including repairs to Pierce Street sewer at outlet end.....	$ 252,000

Richmond-Sunset Sewerage Project.

Baker's Beach Pumping Plant, Diversion Structures, and Connecting Sewer Lines to treatment plant.....	465,000
West Richmond Pumping Plant and Force Main, and Sunset Connecting Sewer Lines	40,000
Richmond-Sunset Treatment Plant.....	543,000
Total.....	$1,300,000

B. Work recommended to be done as soon as funds are available.

North Point and Marina Sewerage Project.

Land for treatment plant site.....	$ 600,000
North Point Treatment Plant, including Pumping Plant, Sewer Line Changes, and Outlet Pipe to bulkhead line.....	1,250,000
Outlet Pipe to approximately 2000 feet from bulkhead line, including Diffusion System.....	400,000
Total.....	$2,250,000

Richmond-Sunset Sewerage Project.

Outlet Pipe to deep water or Complete Treatment in Golden Gate Park	Not estimated.

The cost of the work to be done in the Southeast and the Southwest sewerage districts has not been estimated because of the lack of necessary information regarding the general details of the work required.

In estimating the costs of construction, the cost of local work of similar nature already constructed has been considered wherever possible and modifications made to harmonize them with present prices of materials and labor. More uncertainty with respect to cost exists with reference to tunnel construction than other items; borings may possibly disclose unexpected geological conditions which might increase construction difficulties or cause a relocation. Contract for the tunnel may well be entered into in advance of the rest of the work in order that the total funds needed may be known closely.

ESTIMATED COST OF OPERATION OF TREATMENT WORKS AS OF 1940

Marina Pumping Station			
Power and lighting	$8,000		
Labor.....	2,400		
Materials and supplies...	900		
Total.....			$11,300
Richmond-Sunset Sewerage Project			
Twenty-fifth Avenue North Pumping Station			
Power and lighting.....	$2,400		
Labor.....	1,050		
Materials and supplies...	350		
Sub-total.....		$3,800	
Forty-eighth Avenue and Fulton Street Pumping Station.			
Power and lighting.....	900		
Labor.....	700		
Materials and supplies...	200		
Sub-total.....		$1,800	
Richmond-Sunset Treatment Plant			
Power and lighting.....	$5,000		
Labor *.....	36,000		
Materials and supplies**	1,400		
Chlorine, ferric chloride and other chemicals.....	13,300		
Sub-total.....		$55,700	
Total.....			$61,300

* Includes delivery of sludge but not spreading.

** Cost of water required, 65,000 gallons a day, not included as it is a matter of inter-departmental bookkeeping.

RECOMMENDATIONS.

As a result of this investigation, the following specific recommendations are made:

1. That the sewage of the existing Southeast sewerage district be intercepted and carried to treatment plants at or near China Point, Hunter's Point, and North Point, in accordance with the general plan which the City has been following.
2. That the sewage of the existing North Point sewerage district and of a portion of the existing Southeast sewerage district be pumped at the proposed North Point sewage treatment plant; and that the sewage of the existing North Point, of a part of the existing Southeast, and of the Marina sewerage districts be treated to remove (a) grit, (b) oil, grease, and other floating matter, and (c) the coarser portion of the suspended materials, by means of racks, grit chambers, aerated skimming tanks, and fine screens; and that the treated sewage be discharged at a distance of 2000 feet from the bulkhead line, in water at least 50 feet deep, through a submerged outlet pipe equipped with a system of diffusion nozzles.
3. That the sewage of the Marina sewerage district be pumped through a force main to the North Point treatment plant, the force main being laid for a part of its length within the tunnel of the Belt Line Railroad under Fort Mason.

4. That the North Point sewerage works be constructed as soon as the necessary funds become available, and that, pending their construction, the sewage of the Marina sewerage district be discharged into the Beach Street sewer in The Embarcadero, whence it will flow into the slip between Piers 37 and 39.
5. That land for the North Point sewage treatment plant be acquired as soon as financially practicable, even though construction cannot be undertaken at that time.
6. That the sewage of the major portion of the Baker's Beach sewerage sub-district be diverted and conveyed by gravity through a sewer tunnel from the intersection of Twenty-fourth Avenue and Lake Street to the intersection of Thirty-fourth Avenue and Fulton Street; thence through a sewer in Fulton Street to Forty-sixth Avenue, thence to the proposed treatment plant in Golden Gate Park; and that the sewage of the remainder of the Baker's Beach sub-district be pumped at an underground pumping station situated at the northern end of Twenty-fifth Avenue North, to the proposed sewer at Twenty-fifth Avenue and Lake Street.
7. That the sewage of the major portion of the West Richmond sewerage sub-district be diverted from the existing trunk sewer in Fulton Street at Forty-sixth Avenue and combined with the sewage from the Baker's Beach sub-district at that point; and that the remainder of the sewage of the West Richmond sub-district be concentrated at the existing

pumping station at Forty-eighth Avenue and Fulton Street, and pumped through a force main to that same point, whence all of the sewage would flow by gravity through a proposed sewer leading to the treatment plant.

8. That the sewage of a portion of the Sunset sub-district be diverted and conveyed by gravity from the existing sewer in Lincoln Way at Forty-fifth Avenue to the treatment plant; and that the sewage of the remainder of the Sunset sub-district be diverted and pumped from the existing Mile Rock trunk sewer in Golden Gate Park to the treatment plant.

9. That the sewage of the Mile Rock sewerage district, comprised of the Baker's Beach, West Richmond and Sunset sub-districts, be treated to remove (a) grit, (b) oil, grease, and other floating matter, and (c) that portion of the suspended solids which will settle in a moderate period of time, by means of racks, grit chambers, aerated skimming tanks, and sedimentation tanks; that as much as needed of the effluent be furnished for use in the Park; and that the remainder after chlorination be discharged temporarily into the existing Mile Rock trunk sewer and discharged through the present outlet at the north shore a short distance eastward of Lobos Point; and that the sludge from the sedimentation tanks be subjected to biological digestion in gas tight tanks, that the digested sludge be dewatered by means of vacuum filters, and that the dewatered sludge be furnished for use in the Park, upon municipal golf courses, and other areas.

10. That, in anticipation of the eventual need of providing for the discharge in deep water well offshore of the effluent from the Golden Gate Park treatment plant above described or for complete treatment in the Park, borings and other data be secured which will make possible a reliable estimate of the efficacy and cost of discharge in deep water in comparison with complete treatment; and that, when necessary, the more advantageous of these plans be adopted and executed.

11. That negotiations be undertaken immediately with the authorities of Daly City and the adjoining areas in San Mateo County, which are tributary to the Vista Grande sewer outlet in the extreme southwest corner of the City and County of San Francisco, to the end that provision be made for eliminating the nuisance now existing, due to the sewage from these areas, either by complete treatment and appropriate disposal of the effluent, or by pumping through a force main into the sewers leading to the treatment plant in Golden Gate Park.

12. That the City request the War Department to make provision for delivering all of the sewage of the Presidio and Fort Mason into the sewerage system of the City in order that it may be properly treated together with the City's sewage.

Respectfully presented.

(Signed) Harrison P. Eddy

(Signed) Charles Gilman Hyde

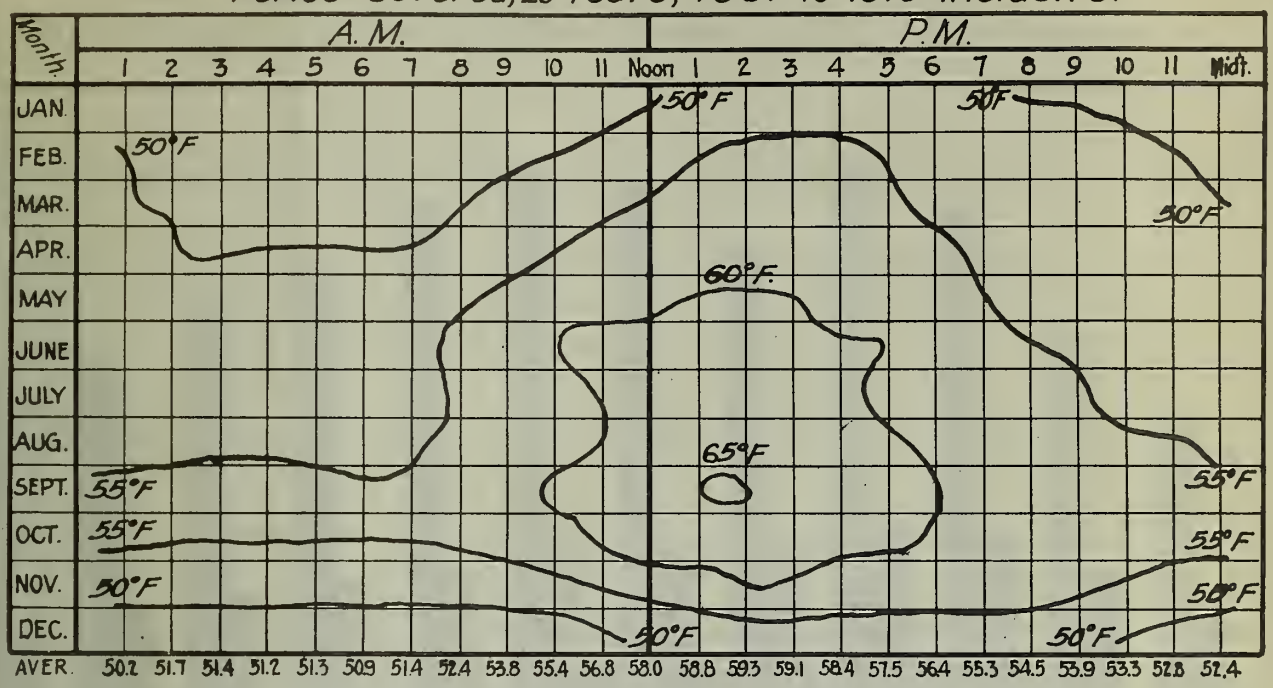
(Signed) Clyde C. Kennedy

(Signed) Leon B. Reynolds

Board of Consulting Sanitary Engineers.

Diagram 1

ISOPLETHS OF AVERAGE HOURLY TEMPERATURES IN DEGREES FAHRENHEIT
SAN FRANCISCO - CALIFORNIA
Period Covered, 20 Years, 1891 to 1910 Inclusive.



Notes: Based upon Table 4, Bulletin 44, "The Climate of San Francisco", by A. G. McAdie, U.S.D.A., Weather Bureau. See Fig. 6, Page 28, Bulletin 44.

AVERAGE HOURLY TEMPERATURES IN DEGREES FAHRENHEIT BY MONTHS			
Month	Temperature	Month	Temperature
January	49.2	JULY	56.0
February	51.3	AUGUST	57.0
March	52.1	September	59.1
April	53.8	October	58.5
May	55.7	November	55.2
June	56.3	December	50.2
Average for the year - 54.6.			

CITY AND COUNTY OF SAN FRANCISCO
DEPT. OF PUBLIC WORKS - BOARD OF CONSULTING SANITARY ENGINEERS

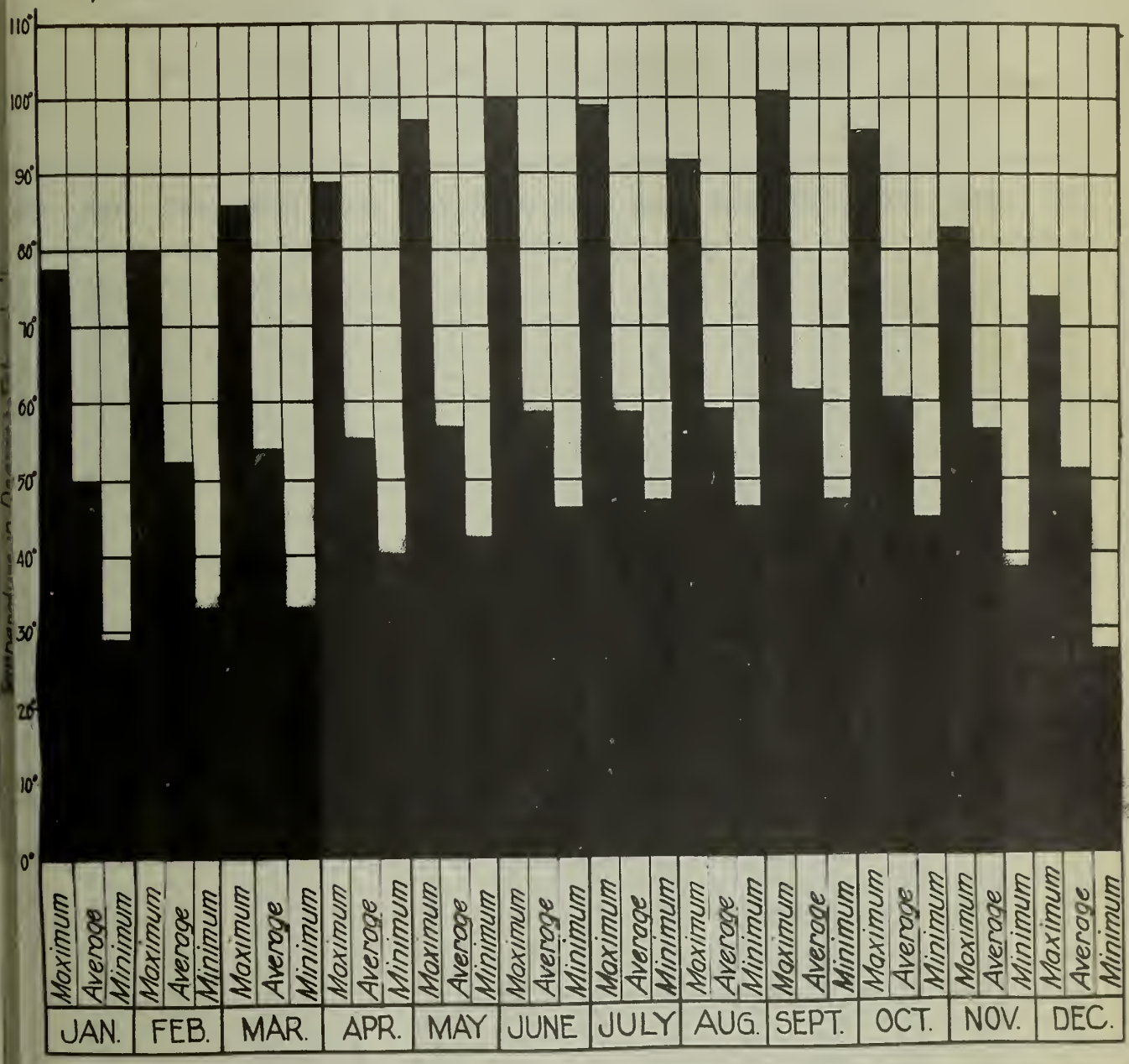
AVERAGE HOURLY TEMPERATURES SAN FRANCISCO.

DRAWN BY R.W.J. TRACED BY R.W.J. CHECKED BY B.B.	SCALE: NO. ---- OF ---- SHEETS	DATE Dec. 6, 1934	FILE L-10,967

PLATE 1

Diagram 2

MAXIMUM, AVERAGE AND MINIMUM MONTHLY TEMPERATURES
SAN FRANCISCO - CALIFORNIA
Period Covered, 63 Years, 1871 to 1933 Inclusive.
Compiled from Records of the Weather Bureau, U.S.D.A., San Francisco.



CITY AND COUNTY OF SAN FRANCISCO
DEPT. OF PUBLIC WORKS - BOARD OF CONSULTING SANITARY ENGINEERS

MONTHLY TEMPERATURES
SAN FRANCISCO.

DRAWN BY R.W.J. TRACED BY R.W.J. CHECKED BY B.B	SCALE: NO. ---- OF ---- SHEETS	DATE May. 3, 1935	FILE L-10,968

PLATE 2

TABLE 1

NORMAL DAILY MEAN TEMPERATURE BY DAYS AND MONTHS
San Francisco, California

Period Covered - 47 years, 1875 to 1921 inclusive

Compiled from Records of the Weather Bureau,
U.S.D.A., San Francisco

Day	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sep.	Oct.	Nov.	Dec.	Day
1	50	51	54	55	56	58	59	58	60	61	59	53	1
2	50	51	54	55	56	58	59	58	60	61	59	53	2
3	50	51	54	55	56	58	59	59	60	61	58	53	3
4	50	51	54	55	56	58	59	59	60	61	58	53	4
5	50	51	54	55	56	58	59	59	60	61	58	53	5
6	50	51	54	55	56	58	59	59	60	61	58	53	6
7	50	51	54	55	56	58	59	59	60	61	58	52	7
8	50	52	54	55	56	58	59	59	61	61	58	52	8
9	50	52	54	55	56	58	59	59	61	61	58	52	9
10	50	52	54	55	56	58	59	59	61	61	57	52	10
11	50	52	54	55	56	58	58	59	61	61	57	52	11
12	50	52	54	55	56	58	58	59	61	61	57	52	12
13	50	52	54	55	56	58	58	59	61	61	57	52	13
14	50	52	54	55	57	59	58	59	61	61	57	51	14
15	50	52	54	55	57	59	58	59	61	61	56	51	15
16	50	52	54	55	57	59	58	59	61	61	56	51	16
17	50	52	54	55	57	59	58	59	61	61	56	51	17
18	50	53	54	55	57	59	58	59	61	60	56	51	18
19	50	53	54	55	57	59	58	59	61	60	56	51	19
20	50	53	54	55	57	59	58	59	61	60	55	51	20
21	50	53	54	55	57	59	58	59	61	60	55	50	21
22	50	53	54	55	57	59	58	59	61	60	55	50	22
23	50	53	54	55	57	59	58	60	61	60	55	50	23
24	50	53	54	55	57	59	58	60	61	60	55	50	24
25	50	53	54	55	58	59	58	60	61	60	55	50	25
26	50	53	54	55	58	59	58	60	61	60	54	50	26
27	50	53	55	55	58	59	58	60	61	60	54	50	27
28	50	53	55	55	58	59	58	60	61	59	54	50	28
29	51	--	55	56	58	59	58	60	61	59	54	50	29
30	51	--	55	56	58	59	58	60	61	59	54	50	30
31	51	--	55	--	58	--	58	60	--	59	--	50	31
Means	50	52	54	55	57	58	58	59	61	60	56	51	

ANNUAL 56.1

Temperatures are given in degrees Fahrenheit.

TABLE 2

STATISTICS OF AVERAGE AND EXTREME TEMPERATURES BY MONTHS

San Francisco, California.
Lengths of Records, as noted

Compiled from Records of the Weather Bureau,
U.S.D.A., San Francisco.

Month	Average Daily Maximum	Average Daily Minimum	Average	Absolute Highest	Absolute Lowest
January	54.9	44.7	50.0	78	29
February	58.4	46.9	52.7	80	33
March	60.7	48.2	54.3	86	33
April	62.2	49.3	55.6	89	40
May	63.3	50.5	56.8	97	42
June	65.5	52.1	58.8	100	46
July	65.1	52.7	58.8	99	47
August	65.2	53.3	59.3	92	46
September	68.3	54.6	61.4	101	47
October	67.7	53.6	60.6	96	45
November	62.8	50.6	56.7	83	38
December	56.1	46.2	51.1	74	27
Year	62.5	50.2	56.4	101	27
Length of record, Years	60	60	64	64	64

Temperatures are given in degrees Fahrenheit.

DIAGRAM 3.

AVERAGE PERCENTAGE of TIME of MONTHLY WIND DIRECTIONS

SAN FRANCISCO - CALIFORNIA

Period Covered 15 Years, 1919-1933 Inclusive

Compiled from Records of the Weather Bureau, U.S.D.A.-S.F.

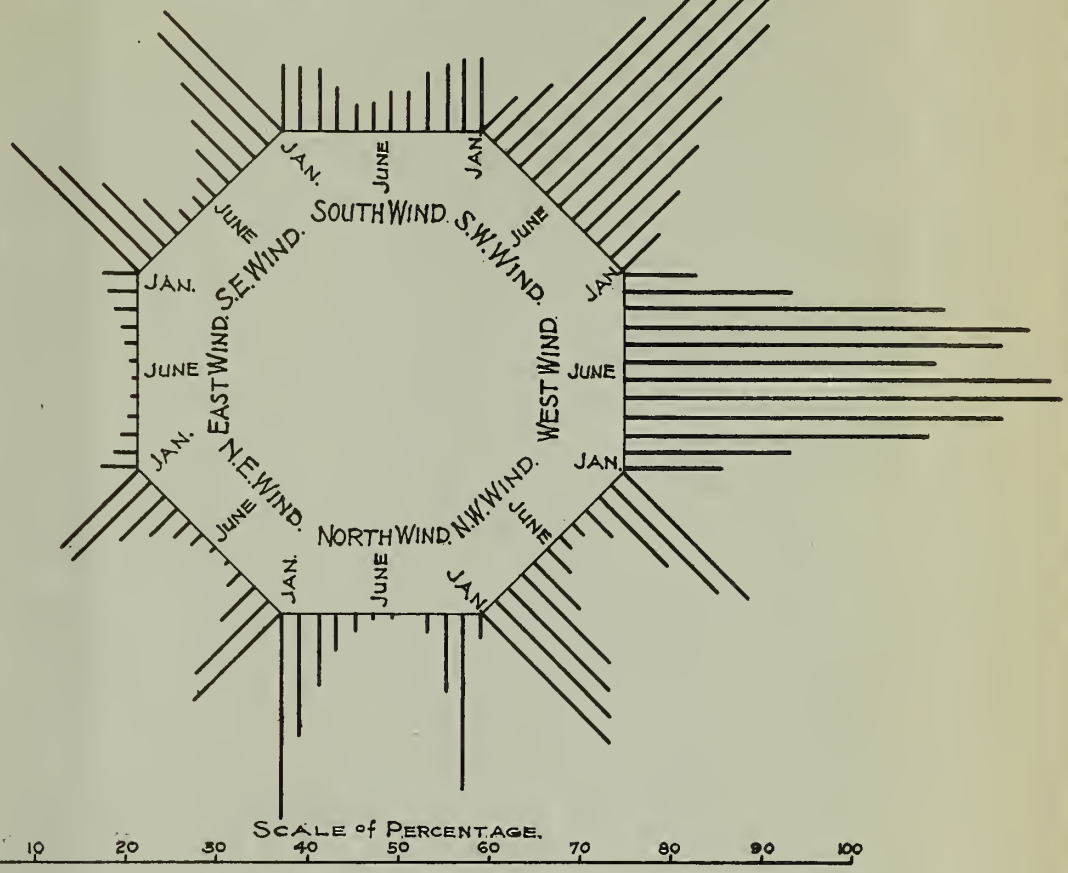


TABLE-3. (PERCENTAGES.)

MONTHLY WIND DIRECTION	JAN.	FEB.	MAR.	APR.	MAY.	JUNE.	JULY.	AUG.	SEPT.	OCT.	NOV.	DEC.
N.	22.2	13.2	7.6	3.7	1.6	.3	.1	.0	1.8	8.4	19.3	23.0
N.E.	11.9	11.9	7.0	4.0	2.3	1.3	.4	.7	1.8	5.1	11.2	13.4
E.	3.7	3.0	2.7	1.6	1.2	.8	.3	.4	1.0	1.8	2.5	3.7
S.E.	18.4	17.0	11.1	7.5	4.9	2.5	1.2	1.6	5.1	9.3	14.1	19.8
S.	8.0	7.8	7.3	6.4	4.3	4.2	3.0	2.8	4.5	7.0	6.9	7.0
S.W.	5.6	10.7	15.4	21.2	30.3	40.0	59.2	51.6	37.0	21.6	9.1	5.2
W.	10.1	18.3	33.3	42.0	48.3	47.1	34.5	41.6	44.3	35.5	18.6	7.9
N.W.	19.9	17.8	15.3	13.5	7.0	3.5	1.2	1.2	3.8	10.5	16.7	19.5
C.	.2	.3	.3	.1	.1	.3	.1	.1	.7	.8	1.6	.5
Total.	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0

C.=Calm.

CITY AND COUNTY OF SAN FRANCISCO

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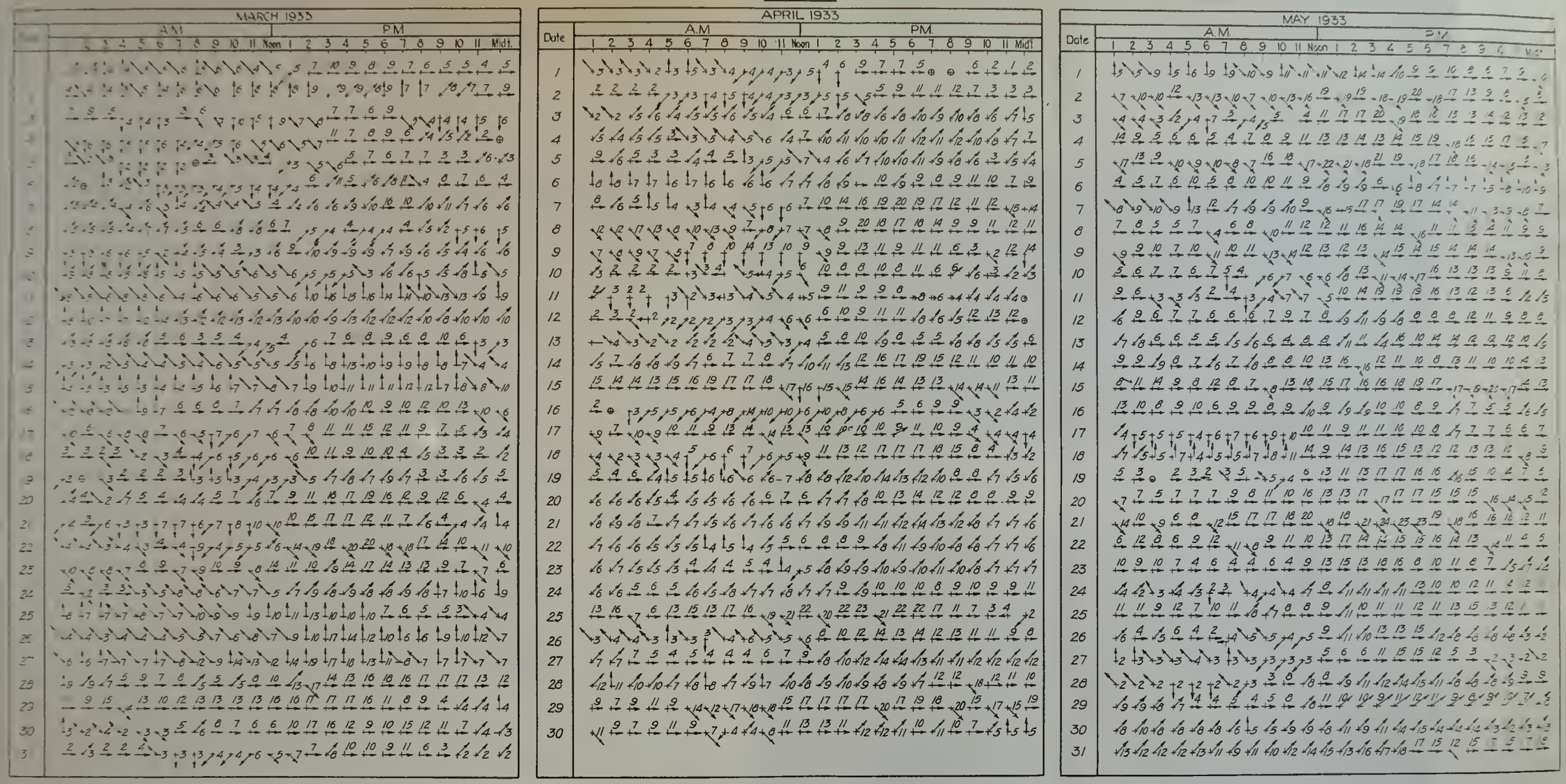
WIND DIRECTION
SAN FRANCISCO.

DRAWN BY R.H.O. TRACED BY M.A. CHECKED BY B.B.	SCALE: NO. .... OF .... SHEETS	DATE April 1935	FILE L-10,969

PLATE 5.

Diagram 4



Note: The figures for each direction arrow denote the velocity in miles per hour.
Compiled from records of the Weather Bureau, U.S.D.A., San Francisco.
⊕ Denotes velocity less than 2 miles per hour.

CITY AND COUNTY OF SAN FRANCISCO
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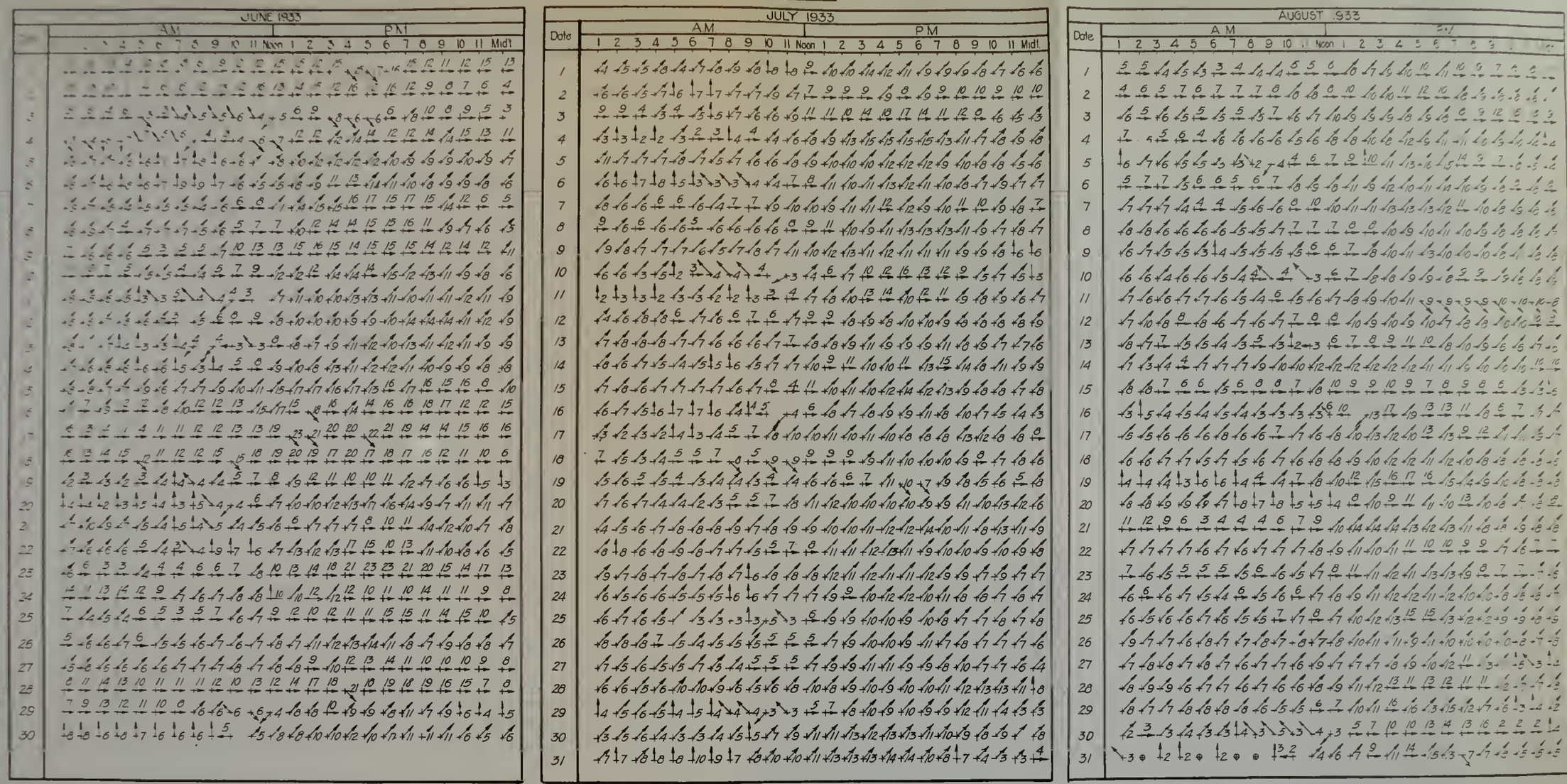
HOURLY WIND DIRECTIONS & VELOCITIES
MARCH - MAY, 1933
SAN FRANCISCO

DRAWN BY R.W.U. TRACED BY R.W.U. CHECKED BY S.B. | SCALE: | NO. OF SHEETS | DATE Dec. 5 1932 | FILE A-10.970

PLATE 6

Diagram 5



Note: The figures for each direction arrow denote the velocity in miles per hour.
Compiled from records of the Weather Bureau, U.S.D.A., San Francisco
⊕ Denotes velocity less than 2 miles per hour.

CITY AND COUNTY OF SAN FRANCISCO
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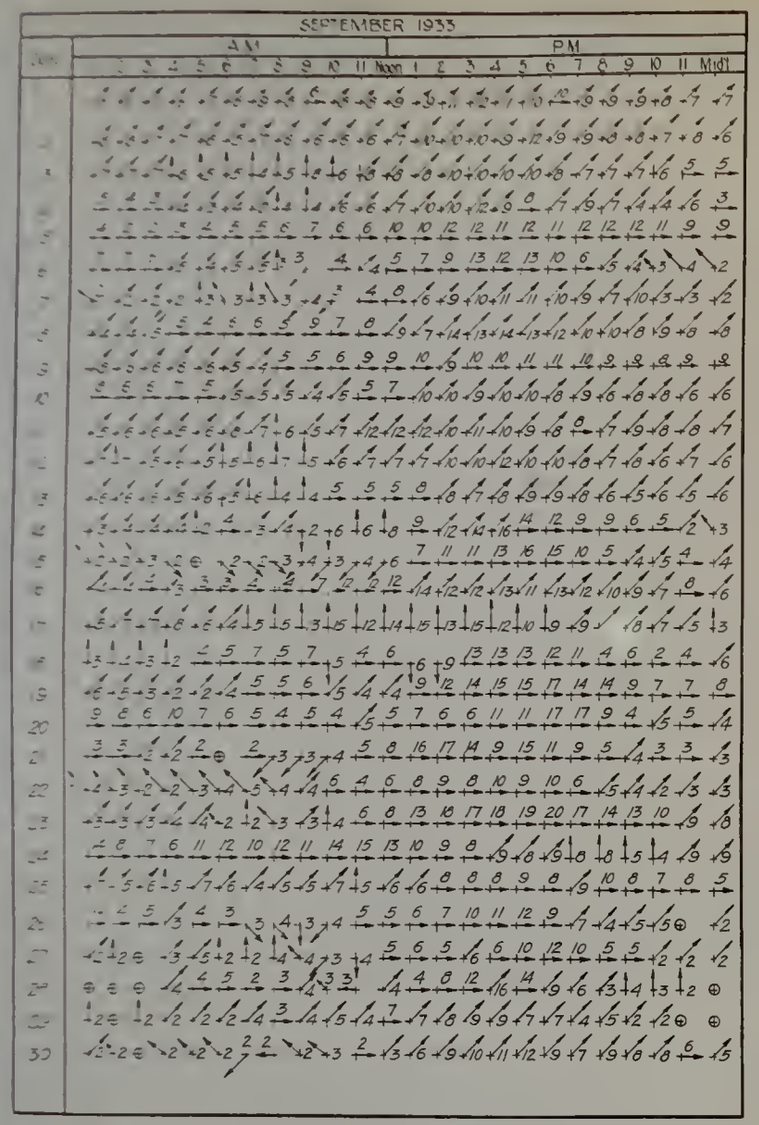
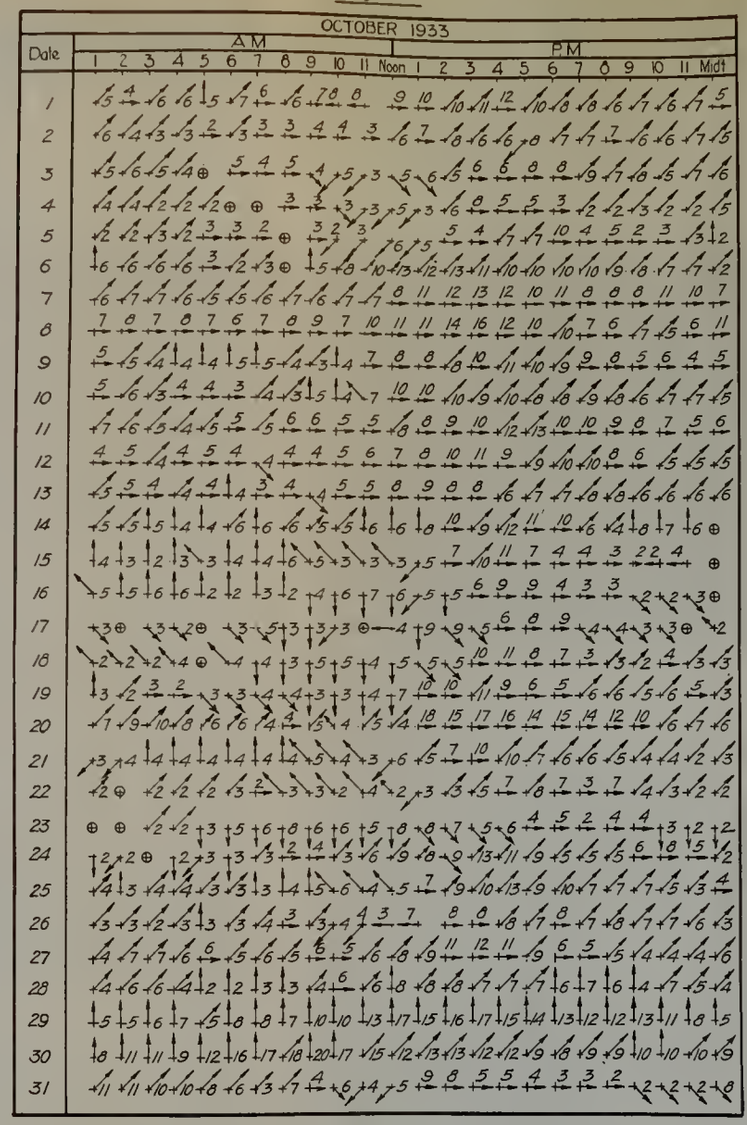
HOURLY WIND DIRECTIONS & VELOCITIES
JUNE - AUGUST, 1933
SAN FRANCISCO.

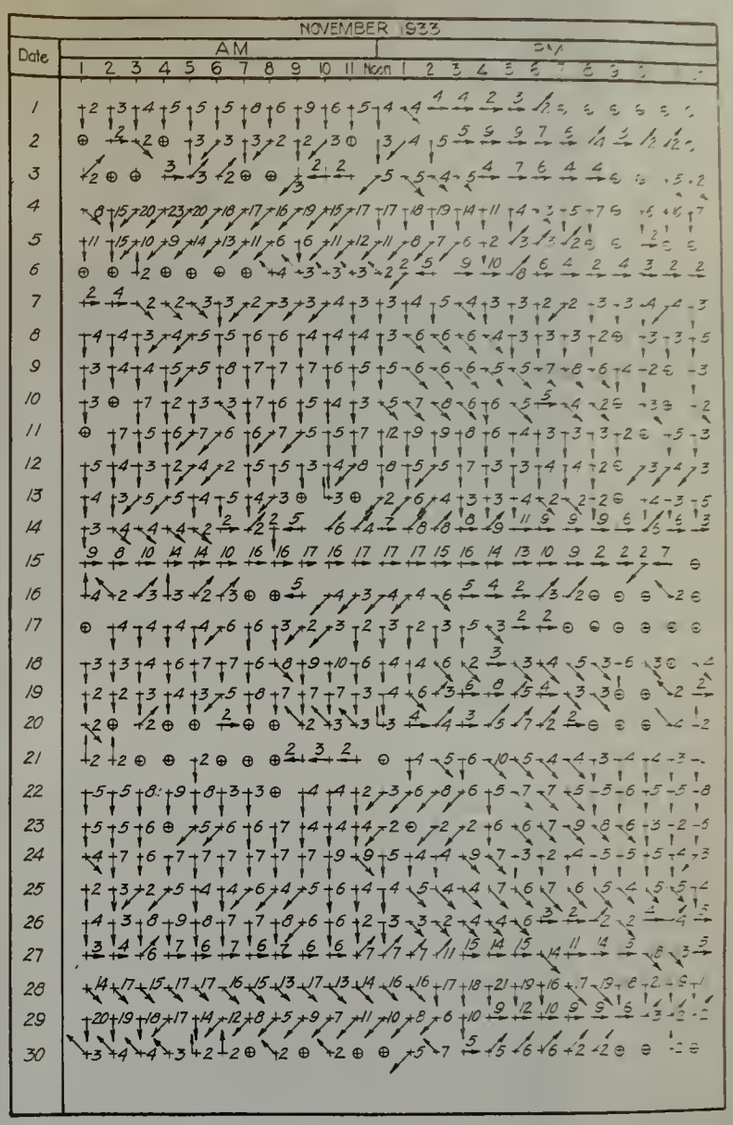
DRAWN BY RWJ
TRACED BY RWJ
CHECKED BY BB
SCALE:
NO OF SHEETS
DATE Dec. 1933
FILE A-10.971

PLATE 7

Diagram 6







Note: The figure for each direction arrow denotes the velocity in miles per hour.
Compiled from records of the Weather Bureau, U.S.D.A., San Francisco.
⊕ Denotes velocity less than 2 miles per hour

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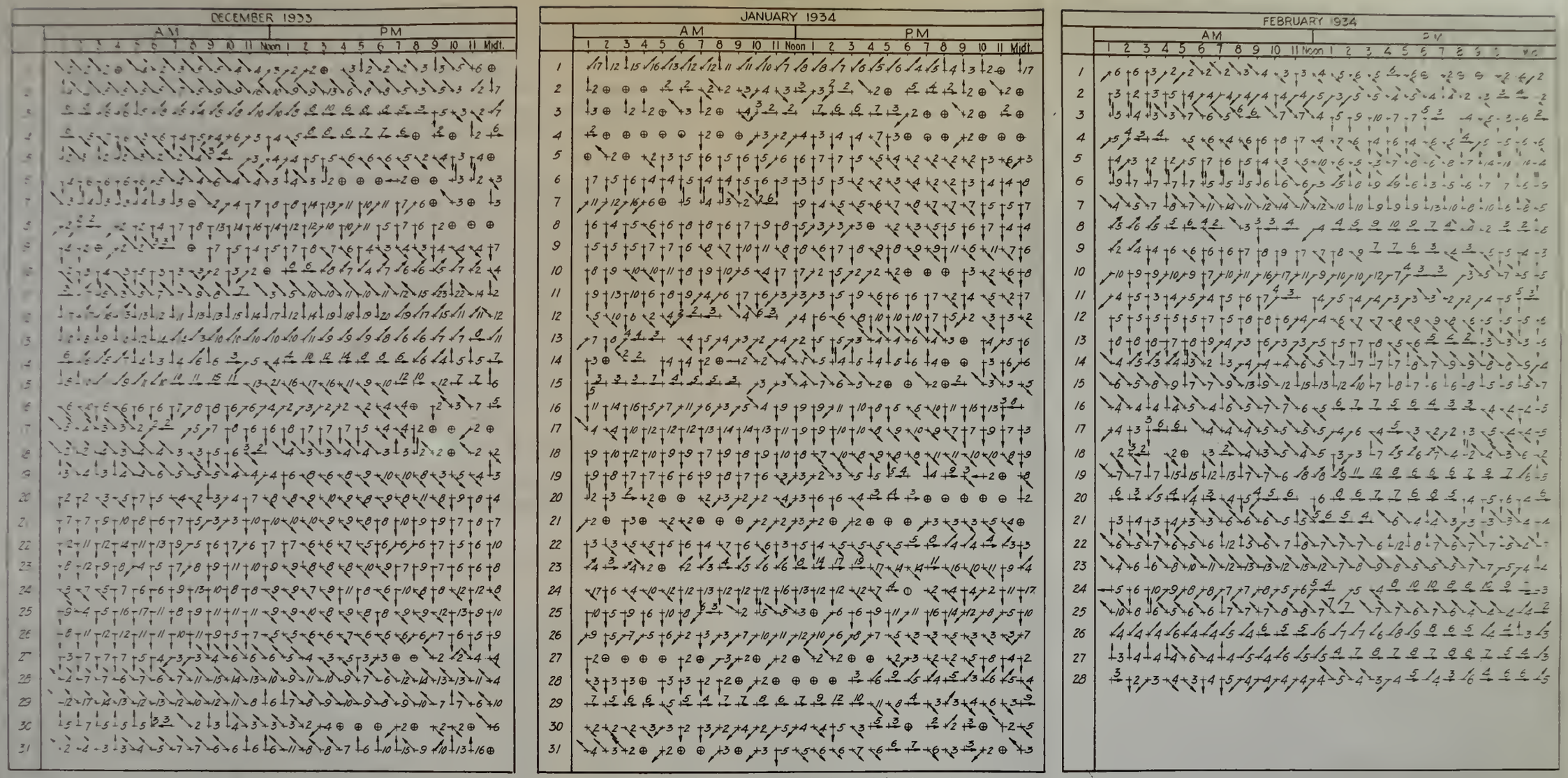
HOURLY WIND DIRECTIONS & VELOCITIES
SEPTEMBER - NOVEMBER, 1933
SAN FRANCISCO.

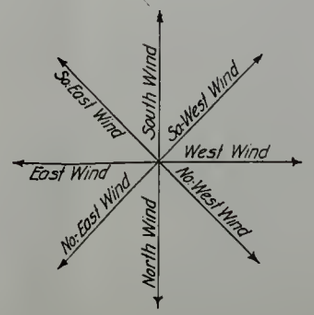
DRAWN BY RWU
TRACED BY RWU
CHECKED BY BB
SCALE:
NO. ..... OF .... SHEETS
DATE Apr. 1935
FILE A-10972

PLATE 8

Diagram 1



Note. The figure for each direction arrow denotes the velocity in miles per hour.
Compiled from records of the Weather Bureau, U.S.D.A., San Francisco.
⊕ Denotes velocity less than 2 miles per hour.



CITY AND COUNTY OF SAN FRANCISCO
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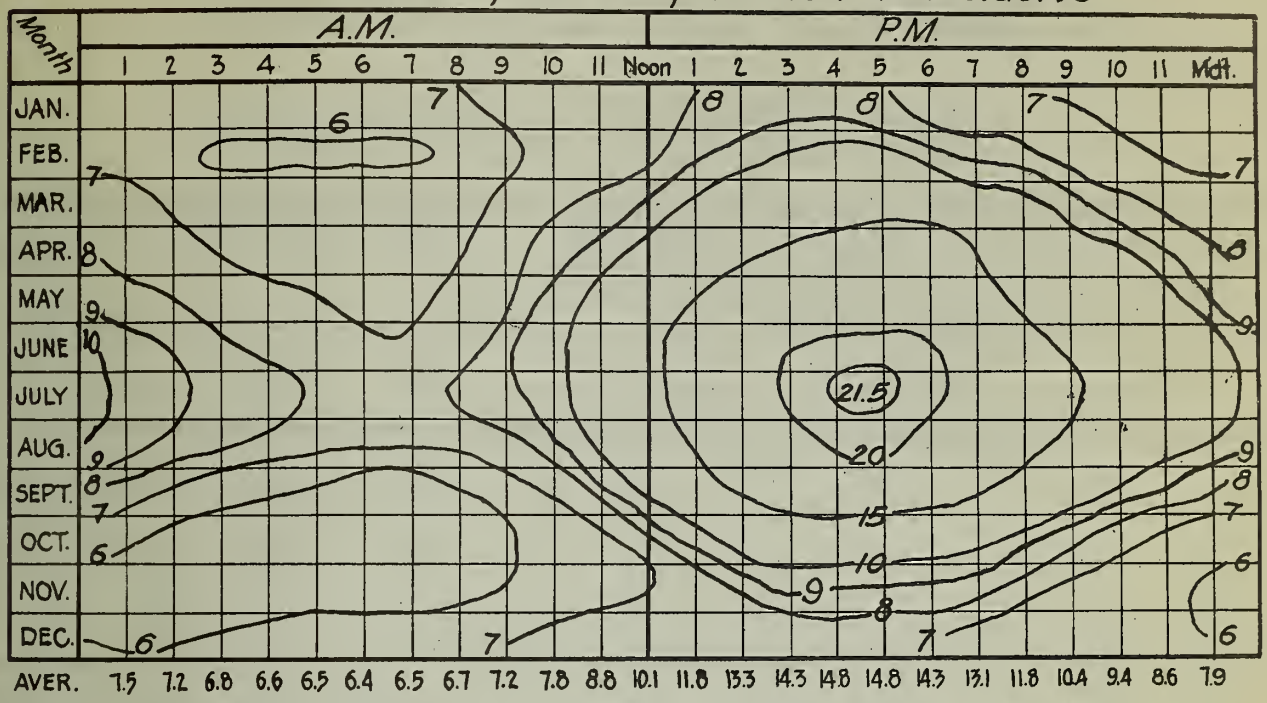
HOURLY WIND DIRECTIONS & VELOCITIES
DECEMBER, 1933 - FEBRUARY, 1934
SAN FRANCISCO.

DRAWN BY RAU TRACED BY RWU CHECKED BY BB	SCALE: NO. ..... OF ..... SHEETS	DATE Apr. 1935	FILE A-10,973

PLATE 9

Diagram 8

ISOPLETHS OF AVERAGE HOURLY WIND VELOCITIES IN MILES
SAN FRANCISCO - CALIFORNIA
Period Covered, 20 Years, 1891 to 1910 Inclusive



Notes:- Based upon Table 5, Bulletin 44, "The Climate of San Francisco," by A.G. McAdie, U.S.D.A., Weather Bureau. See Fig. 11, Page 31, Bulletin 44.

Elevation of anemometer changed from 167 feet to 42 feet on May 1, and to 204 feet on Oct. 1, 1906. (above the street)

AVERAGE HOURLY VELOCITIES IN MILES BY MONTHS			
Month	Velocity	Month	Velocity
January	7.2	July	13.4
February	7.6	August	12.5
March	9.1	September	10.3
April	10.3	October	8.0
May	11.5	November	6.8
June	12.9	December	6.7
Average for the year - 9.7 Miles.			

CITY AND COUNTY OF SAN FRANCISCO
DEPT. OF PUBLIC WORKS - BOARD OF CONSULTING SANITARY ENGINEERS

AVERAGE HOURLY WIND VELOCITY SAN FRANCISCO.

DRAWN BY R.W.J. TRACED BY R.W.J. CHECKED BY B.B.	SCALE: NO. ---- OF ---- SHEETS	DATE Dec. 4, 1934	FILE L-10,974

PLATE 10.

TABLE 4

MAXIMUM, AVERAGE AND MINIMUM MONTHLY RAINFALL IN INCHES AND AVERAGE NUMBER OF DAYS PER MONTH OF STATED DAILY TOTALS, INCHES PER 24 HOURS.

San Francisco, California
Period covered as stated - From Records of Weather Bureau, U.S.D.A. San Francisco

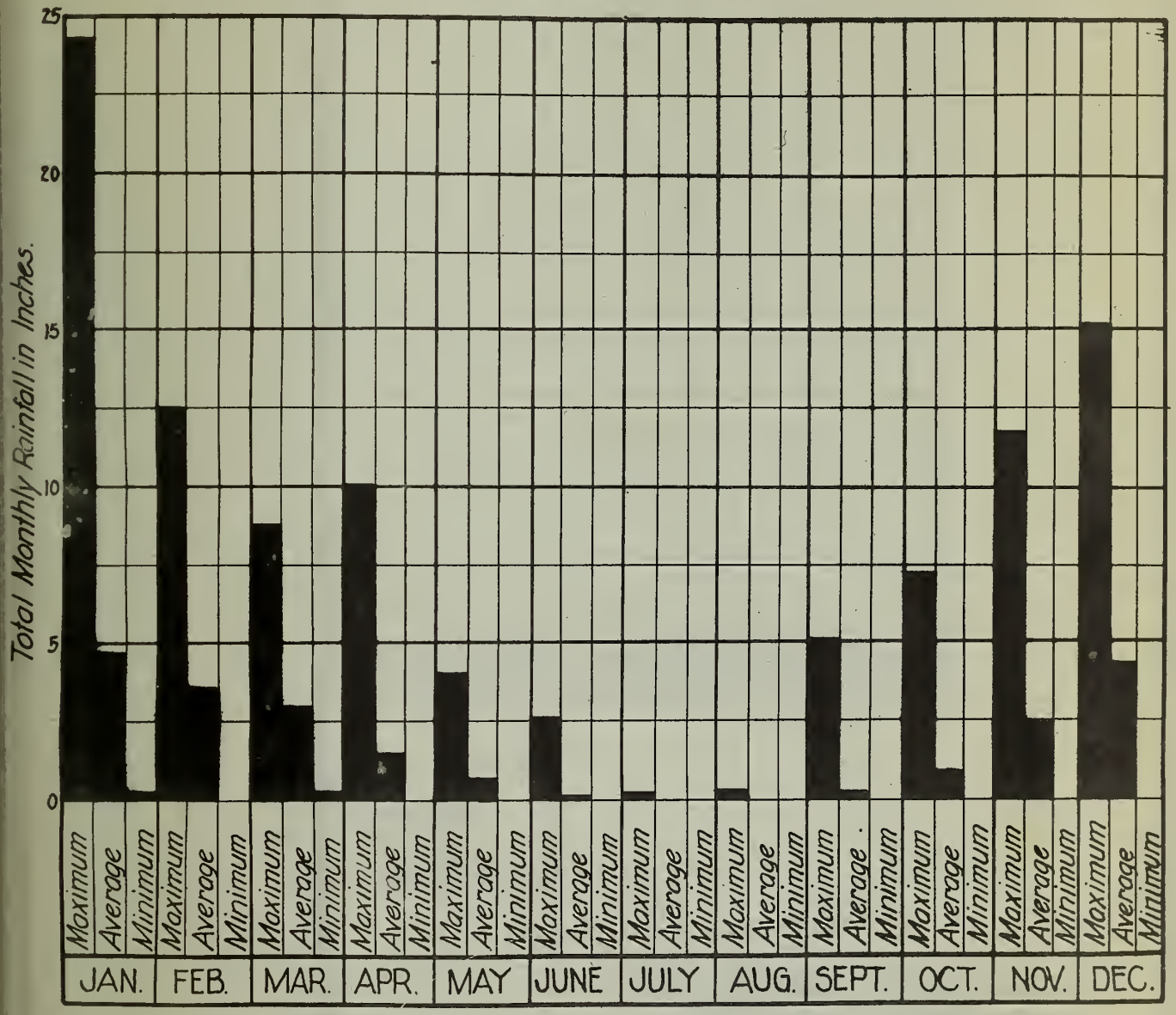
Month	Total Rainfall, Inches 85 yrs. 1849-1933			Average No. of Days when Total Daily Rainfall was equal to or greater than amounts shown during 63 year period, 1871-1933.		
	Max.	Aver.	Min.	0.01 inch	0.25 inch	1.0 inch
Jan.	24.36	4.69	0.26	11	5	1
Feb.	12.52	3.63	0.00	11	5	1
Mar.	8.75	3.01	0.03	8	4	1
Apr.	10.06	1.51	Tr.	6	2	÷
May	4.02	0.70	0.00	4	1	÷
June	2.57	0.15	0.00	2	÷	0
July	0.23	0.01	0.00	1	0	0
Aug.	0.29	0.02	0.00	1	0	0
Sept.	5.07	0.30	0.00	2	÷	÷
Oct.	7.28	0.96	0.00	4	1	÷
Nov.	11.78	7.49	0.00	7	3	1
Dec.	15.16	4.46	0.00	10	5	1
Total 12 mo.	--	21.93	--	67	26	5
Total 7 Mo.*	--	3.65	--	18	4	0

Notes: * San Francisco beaches are mainly used during the seven-month period, April to October, inclusive.

The ÷ sign indicates an average value less than one-half day.

Diagram 9

MAXIMUM, AVERAGE, AND MINIMUM MONTHLY RAINFALL IN INCHES
SAN FRANCISCO - CALIFORNIA
Period Covered, 85 Years, 1849 to 1933 Inclusive.
Compiled from Records of the Weather Bureau, U.S.D.A., San Francisco.



CITY AND COUNTY OF SAN FRANCISCO
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MONTHLY RAINFALL SAN FRANCISCO.

DRAWN BY R.W.J. TRACED BY R.W.J. CHECKED BY B.B.	SCALE: NO. ---- OF ---- SHEETS	DATE May, 6, 1935.	FILE L-10,975

PLATE 12.

Table 5

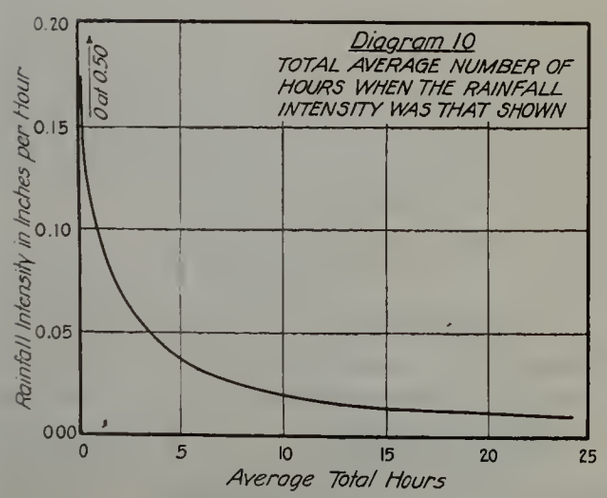
NUMBER OF HOURS DURING THE SEVEN MONTHS PERIOD, APRIL — OCTOBER, OF EACH YEAR FOR 27 YEARS, 1907 - 1933 INCLUSIVE, WHEN THE INTENSITY OF RAINFALL IN INCHES PER HOUR WAS THAT STATED

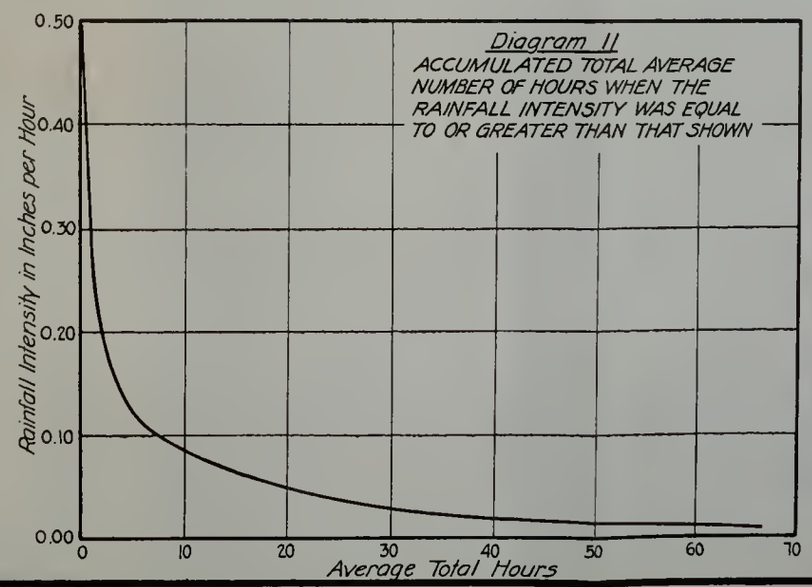
SAN FRANCISCO - CALIFORNIA.

Compiled from Records of the Weather Bureau, United States Department of Agriculture, San Francisco.

Year	.01	.02	.03	.04	.05	.06	.07	.08	.09	.10	.11	.12	.13	.14	.15	.16	.17	.18	.19	.20	.21	.22	.23	.24	.25	.26	.27	.28	.29	.30	.31	.32	.33	.34	.35	.36	.37	.38	.39	.40	.41	.42	.43	.44	.45	.46	.47	.48
1907	26	9	9	8	5	4	1	1		2	1	1	1	2				1														1																
1908	41	12	1	5	4	3	2				2																																					
1909	16	7	12	4	6	3		3	1	1	1								1																													
1910	13	10	5	1	1		2	1		1							1																															
1911	15	8	5	4		2	1	1	2		1			1		1																																
1912	50	29	14	7	5	6	4	2	4	5		2	1	1	1			1				1				1												1										
1913	12	8	6	2	2	2	4	2	1	2		1																																				
1914	43	9	6	3	3		3	1	1				1		1								1																									
1915	30	23	17	9	2		2	8	1	3			1	1	1			1											1																			
1916	18	10	4	2	4	2		1		1			1		1	3							1																									
1917	17	3					1				1																																					
1918	12	8	11	11	6	6	6	5	1	1			1				1			1				1																								
1919	7	5	12	1	1		2																																									
1920	22	10	6	6	7	2	1		3	1	4	1			1						1			1																		1						
1921	25	18	6	4	2	2	2		1	1			2			1																																
1922	18	7	7	6	3	4		1	1	6	2		2	3					2		1														1											1		
1923	35	9	4	6	6	5	3	6	1	2	3	1	2	2		1		1			2								1																			
1924	14	9	5	4	2	3	2	3	1	2		4		1		1	3	1					1																									
1925	49	18	8	6	13	8	2	4	7	6	1	5		1	2	1			2			2						1	1			1			1													
1926	27	8	10	8	8	4	4	2	4	3	1	2	2		2	2	2	1	2			2		1	1						1							2	1									
1927	23	10	6	4	2	4	2	3	3	2	5	1		2								1		4	1																							
1928	23	6	3	3	1	1	2	2	1	1	1	1																1																				
1929	27	7	12	5	2	4	1	1	2	1				1																																		
1930	18	6	4	3	5	1	5	2						1		1			1							1																						1
1931	16	11	9	5	2	3	2	2	3	3	1			1			1																															
1932	21	7	8	1	2	2	1			2		1																																				
1933	19	10	7	5	3	4	2	2			1	1		1				2		1											1	1																
Average	24.	10.	7.3	4.6	3.6	2.8	2.1	2.0	1.4	1.7	.93	.77	.52	.67	.33	.41	.30	.30	.30	.07	.15	.22	.11	.36	.07	.07	.00	.07	.11	.00	.07	.11	.00	.00	.07	.00	.00	.11	.04	.00	.00	.04	.00	.00	.00	.04	.00	.04
Accum*	65.7	41.7	31.7	24.4	19.8	16.2	13.4	11.35	9.35	7.95	6.25	5.32	4.55	4.03	3.36	3.06	2.65	2.35	2.05	1.75	1.68	1.53	1.31	1.2	.84	.77	.70	.70	.63	.52	.52	.45	.34	.34	.34	.27	.27	.27	.16	.12	.12	.12	.08	.08	.08	.08	.04	.04

Note. * Accumulated total average number of hours when the rainfall intensity was equal to or greater than that shown.





CITY AND COUNTY OF SAN FRANCISCO
DEPARTMENT OF PUBLIC WORKS
BOARD OF CONSULTING SANITARY ENGINEERS
H. P. EDDY, Chairman. C. G. HYDE, Secretary.
L. B. REYNOLDS C. C. KENNEDY

RAINFALL INTENSITY
APRIL - OCTOBER
SAN FRANCISCO.

DRAWN BY B.B. R.V.
TRACED BY R.J.
CHECKED BY B.B.
SCALE:
NO. ..... OF ... SHEETS
DATE Nov. 16 1934.
FILE A-10,976

PLATE 13

Table 6

NUMBER OF STORMS AND NUMBER OF HOURS DURING THOSE STORMS WHEN CERTAIN STATED INTENSITIES OF RAINFALL PREVAILED DURING THE SEVEN MONTHS PERIOD, APRIL-OCTOBER, IN EACH OF THE 27 YEARS 1907-1933. SAN FRANCISCO

Year	Conditions	April		May		June		July		August		September		October		Totals	
		Storms	Hours	Storms	Hours	Storms	Hours	Storms	Hours	Storms	Hours	Storms	Hours	Storms	Hours	Storms	Hours
1907	1	4	6	4	4	8	23			1	2	1	4	12	33	30	72
	2	3	5	4	4	3	7			1	2		1	3	7	14	26
	3					3	8					1	3	3	15	7	26
	4	1	1			2	8							6	11	9	20
1908	1	9	17	9	18	1	1	2	2	1	1	6	9	8	22	36	70
	2	5	12	5	11	1	1	2	2	1	1	4	6	1	8	19	41
	3	4	5									2	3	5	10	11	18
	4			4	1									2	4	6	11
1909	1											8	26	9	29	17	55
	2											2	1	2	9	4	16
	3											2	13	2	10	4	23
	4											4	6	5	10	9	16
1910	1	7	9	2	2	1	1					2	3	10	20	22	35
	2	2	4	1	1							1	1	3	1	1	13
	3	3	3	1	1	1	1					1	2	4	9	10	16
	4	2	2											3	4	5	6
1911	1	10	24	5	9	3	3							4	5	22	41
	2	5	9	1	2	3	3							1	1	10	15
	3	3	9	3	6									1	2	7	17
	4	2	6	1	1									2	2	3	9
1912	1	14	40	15	35	8	28					5	18	5	14	47	135
	2	3	13	6	13	4	14					1	5	1	5	15	50
	3	5	16	5	13	2	9					1	5	2	1	15	50
	4	6	11	4	9	2	5					3	8	2	2	17	35
1913	1	1	16	3	12	2	2	3	5	1	1			2	6	20	42
	2	2	3			2	2	1	3	1	1			1	1	7	12
	3	3	6	1	6			2	2						2	6	16
	4	2	5	4	6									1	3	1	14
1914	1	12	26	8	17	6	18	2	2					4	9	32	72
	2	8	14	6	12	2	10	2	2					3	5	21	43
	3	1	6	1	3	4	8								1	6	18
	4	3	6	1	2									1	3	5	11
1915	1	10	28	23	70			1	1					1	1	35	100
	2	8	10	4	18			7	1					1	1	12	30
	3	3	17	8	32											11	49
	4	1	1	11	20											12	21
1916	1			1	1			2	2	3	9	5	17	12	19	23	48
	2							1	1	1	5	2	4	4	8	8	18
	3							1	1	7	2		6	4	7	6	16
	4			1	1					1	2	3	7	4	4	9	14
1917	1	1	14	5	6							1	2			13	22
	2	3	9	5	6							1	2			9	17
	3	3	3													3	3
	4	1	2													1	2
1918	1	3	13									5	46	7	12	15	71
	2		1									2	2	5	9	7	12
	3	1	1									1	20	2	3	4	30
	4	2	5									2	24			4	29
1919	1	3	6									6	13	4	9	13	28
	2	2	4									1	2	1	1	4	7
	3	1	2									3	9	2	7	6	18
	4											2	2	1	1	3	3
1920	1	7	30			2	3					1	3	12	31	22	67
	2	2	6			1	2					1	2	4	12	8	22
	3	1	13				1							3	8	5	22
	4	4	11										1	5	11	9	23
1921	1	6	12	11	19							6	14	9	19	32	64
	2	2	6	4	1							3	6	2	6	11	25
	3	2	3	4	9							2	7	4	9	12	28
	4	2	3	3	3							1	1	3	4	9	11
1922	1	4	10	5	12	3	4							16	39	28	65
	2	2	4	1	2	2	2							6	10	11	18
	3	1	3	1	4									2	13	4	20
	4	1	3	3	6	1	2							8	16	13	27
1923	1	12	59	4	6	2	4			1	1	4	8	7	12	30	90
	2	2	16	4	6	1	3			1	1	2	5	1	4	11	35
	3	2	12			1	1							5	6	8	19
	4	8	31									2	3	1	2	11	36
1924	1	3	7											14	49	17	56
	2		1											5	13	5	14
	3	1	3											3	15	4	18
	4	2	3											6	21	8	24
1925	1	17	49	25	68	1	1	2	5			5	9	5	7	55	139
	2	5	14	13	24			1	4			1	3	3	4	23	49
	3	4	13	3	13			1	1			1	3	1	2	10	32
	4	8	22	9	31	1	1					3	3	1	1	22	58
1926	1	19	63	5	7					1	4			9	26	34	100
	2	4	14	3	4					1	4			3	5	11	27
	3	6	19	2	3									2	4	10	26
	4	9	30											4	17	13	47
1927	1	1	34	2	3	2	5							9	31	20	73
	2	2	10			1	3							4	10	7	23
	3	1	8	2	3									1	9	4	20
	4	4	16			1	2							4	12	9	30
1928	1	11	28	2	7							3	3	5	8	21	46
	2	4	10	1	4							3	3	4	6	12	23
	3	4	10											1	2	5	12
	4	3	8	1	3											4	11
1929	1	14	31	1	1	7	30							1	1	23	63
	2	5	11	1	1	3	14							1	1	10	27
	3	4	13			3	11									7	24
	4	5	7			1	5									6	12
1930	1	12	24	2	3							4	6	3	16	21	49
	2	3	11	1	2							3	3	1	2	10	18
	3	2	5										2		6	2	13
	4	5	8	1	1							1	7	2	8	9	18
1931	1	6	12	4	19	4	8							7	20	21	59
	2	2	4	2	4	2	3							2	5	8	16
	3	3	1		5		3							2	10	5	25
	4	1	1	2	10	2	2							3	5	8	18
1932	1	11	21	11	20	2	3							1	1	25	45
	2	5	10	3	7	2	3							1	1	11	21
	3	4	9	3	7											7	16
	4	2	2	5	6											7	8
1933	1	2	4	9	25	1	1					3	9	9	21	24	60
	2	1	3	1	4	1	1					2	6	3	5	8	19
	3	1	1	4	11							1	3	4	7	10	22
	4			4	10									2	9	6	19
Average for 27 Years	1	8.0	21.6	5.8	13.5	2.0	5.0	0.4	0.6	0.3	0.7	2.4	7.0	6.8	17.0	25.7	65.4
	2	3.0	7.6	2.4	4.9	1.0	2.5	0.3	0.5	0.2	0.5	1.1	2.1	2.4	5.4	10.4	23.5
	3	2.3	7.2	1.4	4.3	0.6	1.6	0.1	0.1	0.05	0.1	0.5	2.0	2.0	6.1	7.0	22.3
	4	2.7	6.8	2.0	4.3	0.4	0.9	0.0	0.0	0.05	0.1	0.8	2.0	2.4	5.5	8.3	19.5

Conditions are to be interpreted as follows.
1 = Total Number of Storms and Hours.
2 = Number of Storms and Hours of 0.01" Per Hour or Less
3 = Number of Storms and Hours With Rainfall Intensity between 0.02" and 0.04" * per hour.
4 = Number of Storms and Hours With Rainfall Intensity in Excess of 0.04" per hour.
A storm has been considered to be a rain of 0.01" per hour or more continuing for one hour or more.
Compiled from Records of the Weather Bureau, United States Dept. of Agriculture, San Francisco.
* Inclusive.

CITY AND COUNTY OF SAN FRANCISCO
DEPARTMENT OF PUBLIC WORKS
BOARD OF CONSULTING SANITARY ENGINEERS
H. P. EDDY, Chairman. C. G. HYDE, Secretary.
L. B. REYNOLDS C. C. KENNEDY

RAINFALL INTENSITY
BY STORMS AND HOURS.
APRIL - OCTOBER
SAN FRANCISCO.

DRAWN BY R.W.J. TRACED BY R.W.J. CHECKED BY B.B.	SCALE: NO. ..... OF ..... SHEETS	DATE May 1 1935.	FILE A-10,977

PLATE 14.

TABLE 7

COMPARATIVE RAINFALL INTENSITIES DURING THE SEVEN MONTH PERIOD, APRIL - OCTOBER

BASED ON RECORDS FOR 27 YEARS, 1907 - 1933.

Compiled from Records of the Weather Bureau, U.S.D.A., San Francisco.

Storm Intensities.	THE AVERAGE YEAR.					A VERY WET YEAR (1912).					A VERY DRY YEAR (1924).				
	Total Number of Storms.	No. of days between storms	Duration: Each Storm, Hours	Duration: Total Hours of Storms	Per Cent of Time	Total Number of Storms	No. of Days Between Storms	Duration: Each Storm, Hours	Duration: Total Hours of Storms	Per Cent of Time	Total Number of Storms	No. of Days Between Storms	Duration: Each Storm, Hours	Duration: Total Hours of Storms	Per Cent of Time
.01 inch per hour or less.	10.4	20	2.26	23.5	0.47	15	14	3.35	50	1.0	5	42	2.8	14	0.28
Between .01 and .04 inches per hour.	7.0	30	3.2	22.3	0.44	15	14	3.35	50	1.0	4	52	4.5	18	0.36
Above .04 inches per hour.	8.3	25	2.36	19.6	0.39	17	12	2.05	35	0.7	8	26	3.0	24	0.48
Averages and Totals.	25.7	8.2	2.55	65.4	1.30	47	4.5	2.87	135	2.7	17	12.4	3.3	56	1.12

Plate 15

TABLE 7

NUMBER OF DAYS WHEN
RAINFALL INTENSITY WAS
GREATER THAN 0.01 INCH PER HOUR

DURING THE SEVEN-MONTH PERIOD, APRIL TO OCTOBER, INCLUSIVE

San Francisco, California.

Period covered, 15 years, 1915-1929 as shown.

Compiled from Records of Weather Bureau,
U.S.D.A., San Francisco.

Year	April	May	June	July	August	September	October	Total
1915	4	10						14
1916		1		1	2	2	6	12
1917	3							3
1918	3					3	3	9
1919	1					3	2	6
1920	3		1			1	6	11
1921	2	6				3	4	15
1922	1	2	1				8	12
1923	7		1			2	5	15
1924	2						9	11
1925	6	8	1	1		3	2	21
1926	7	2					3	12
1927	4	2	1				3	10
1928	5	1					1	7
1929	5		4					9
Average	3.5	2.1	0.6	0.1	0.1	1.1	3.6	11.1

Note: San Francisco beaches are mainly used during the seven-month period, April to October, inclusive.

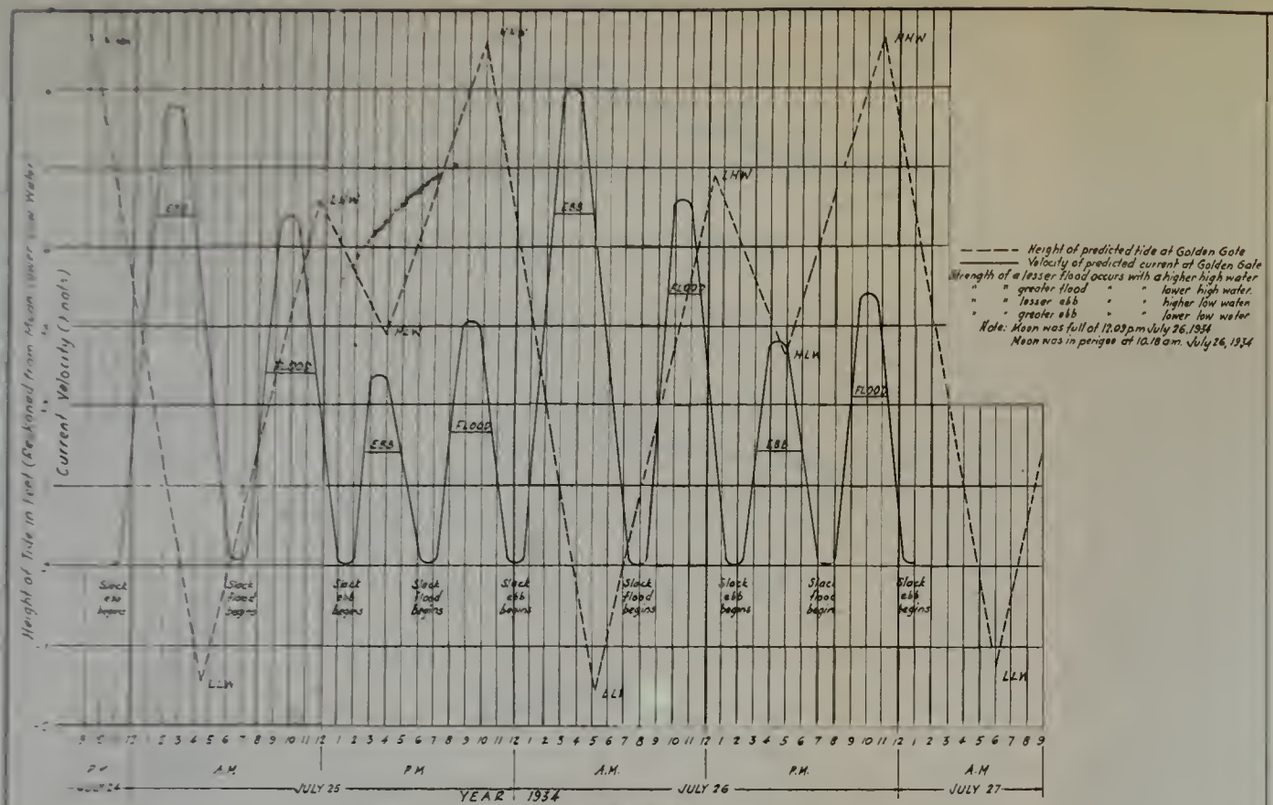


DIAGRAM 12.

ILLUSTRATING VARIATION IN CURRENT VELOCITIES AND HEIGHT OF TIDE

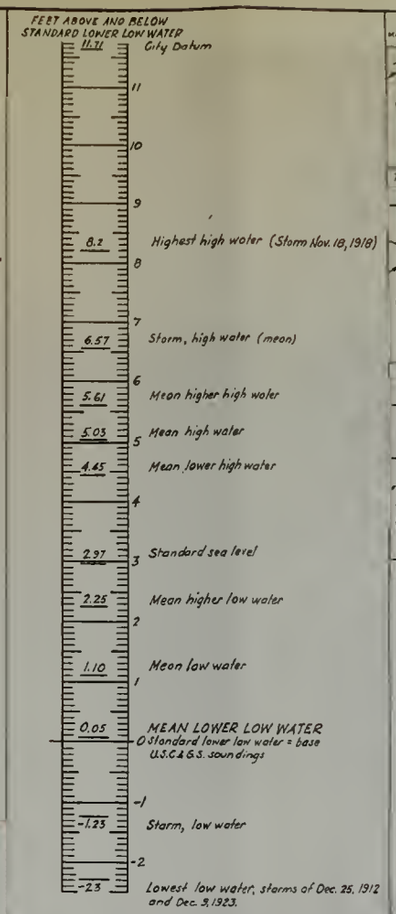
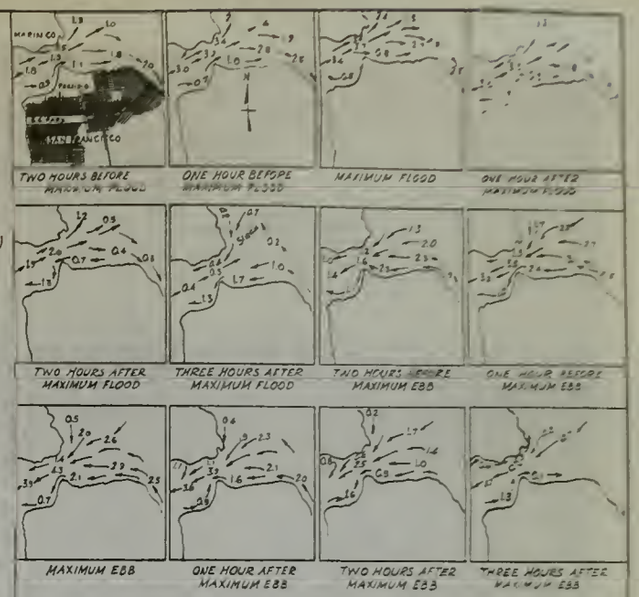


DIAGRAM 13.

ILLUSTRATING HEIGHT OF VARIOUS TIDAL PLANES



Arrows denote the direction and figures the velocity of the current. Velocities are in knots and are for the time of tropic currents; that is the greater flood and ebb currents at time of the moons maximum declination.

FACTORS FOR CORRECTING VELOCITIES.

Maximum Flood.		Maximum Ebb	
Predicted Velocity (Knots)	Factors to apply to velocities on charts	Predicted Velocity (Knots)	Factors to apply to velocities on charts
0.8-1.0 Multiply by	0.1	0.6-0.9 Multiply by	0.1
1.1-1.3 " "	0.2	1.0-1.3 " "	0.2
1.4-1.5 " "	0.3	1.4-1.6 " "	0.3
1.6-1.7 " "	0.4	1.7-1.9 " "	0.4
1.8-2.0 " "	0.5	2.0-2.3 " "	0.5
2.1-2.3 " "	0.6	2.4-2.7 " "	0.6
2.4-2.7 " "	0.7	2.8-3.2 " "	0.7
2.8-3.1 " "	0.8	3.3-3.6 " "	0.8
3.2-3.4 " "	0.9	3.7-4.0 " "	0.9
3.5-3.8 " "	1.0	4.1-4.5 " "	1.0
3.9-4.2 " "	1.1	4.6-4.7 " "	1.1
4.3-4.6 " "	1.2	5.0-5.3 " "	1.2
4.7-5.0 " "	1.3	5.4-5.7 " "	1.3
5.1-5.4 " "	1.4	5.8-6.2 " "	1.4

Predicted velocities refer to velocities at the Golden Gate as shown in current tables.

DIAGRAM 14

TIDAL CURRENT CHARTS

Month		FLOOD TIDES				EBB TIDES				SLACKS			
		HIGH		LOW		HIGH		LOW		UPPER		LOWER	
										H.F. to Ebb.	L.F. to Ebb.	H.E. to Flood	L.E. to Flood
		Duration	Velocity	Duration	Velocity	Duration	Velocity	Duration	Velocity	Duration	Duration	Duration	Duration
March	Average	4.6	3.7	3.9	2.5	4.9	4.1	3.1	2.6	1.3	1.7	2.1	2.4
	Maximum	5.6	4.2	5.3	4.2	5.8	4.9	4.6	4.4	1.7	2.0	2.4	3.1
	Minimum	3.9	1.7	2.3	1.0	4.2	3.0	2.1	1.0	1.1	1.3	1.9	1.5
June	Average	4.9	3.4	3.4	2.2	5.2	4.5	3.1	2.2	1.3	1.7	2.0	2.4
	Maximum	5.5	4.7	4.5	3.0	5.2	6.1	5.0	3.1	1.7	2.2	2.2	2.8
	Minimum	4.0	1.9	2.9	1.4	4.2	2.6	2.3	1.6	1.1	1.5	2.7	2.0
September	Average	4.8	3.2	3.8	2.4	5.2	4.1	2.6	2.5	1.2	1.6	2.2	2.4
	Maximum	5.6	4.4	4.3	4.2	6.2	5.0	4.4	3.9	2.0	2.1	2.4	2.8
	Minimum	4.1	2.5	3.5	1.2	4.1	3.2	2.5	1.1	1.0	1.1	1.8	2.1
December	Average	4.6	3.3	3.7	2.2	5.2	4.3	3.0	2.1	1.2	1.7	2.1	2.5
	Maximum	5.4	4.2	4.7	3.2	5.9	5.7	4.2	3.0	1.5	2.3	2.7	2.7
	Minimum	4.2	1.9	2.8	1.6	4.5	2.7	2.1	1.3	1.2	1.3	1.7	2.0
Average	Average	4.7	3.4	3.7	2.4	5.1	4.2	3.0	2.4	1.3	1.7	2.1	2.4
	Maximum	5.5	4.4	4.7	3.65	5.95	5.4	4.6	3.6	1.7	2.2	2.4	2.8
	Minimum	4.05	1.75	3.0	1.3	4.25	2.85	2.5	1.25	1.1	1.3	1.8	1.9

Flood represents the greater difference between low water and high water
Ebb " " " " " high " " low "
Velocities are in knots and durations in hours.
Data from Tide Tables 1934 and Current Tables 1934

TABLE 9

TIDE DATA
MARCH-JUNE-SEPTEMBER-DECEMBER
1934

CITY AND COUNTY OF SAN FRANCISCO
DEPARTMENT OF PUBLIC WORKS
BOARD OF CONSULTING SANITARY ENGINEERS
H. P. EDDY, Chairman. C. G. HYDE, Secretary
L. B. REYNOLDS C. C. KENNEDY

TIDAL DATA
SAN FRANCISCO.

DRAWN BY J.S.
TRACED BY J.S.
CHECKED BY B.B.
SCALE:
NO. ..... OF ..... SHEETS
DATE May 1935
FILE A-10.978

PLATE 17.

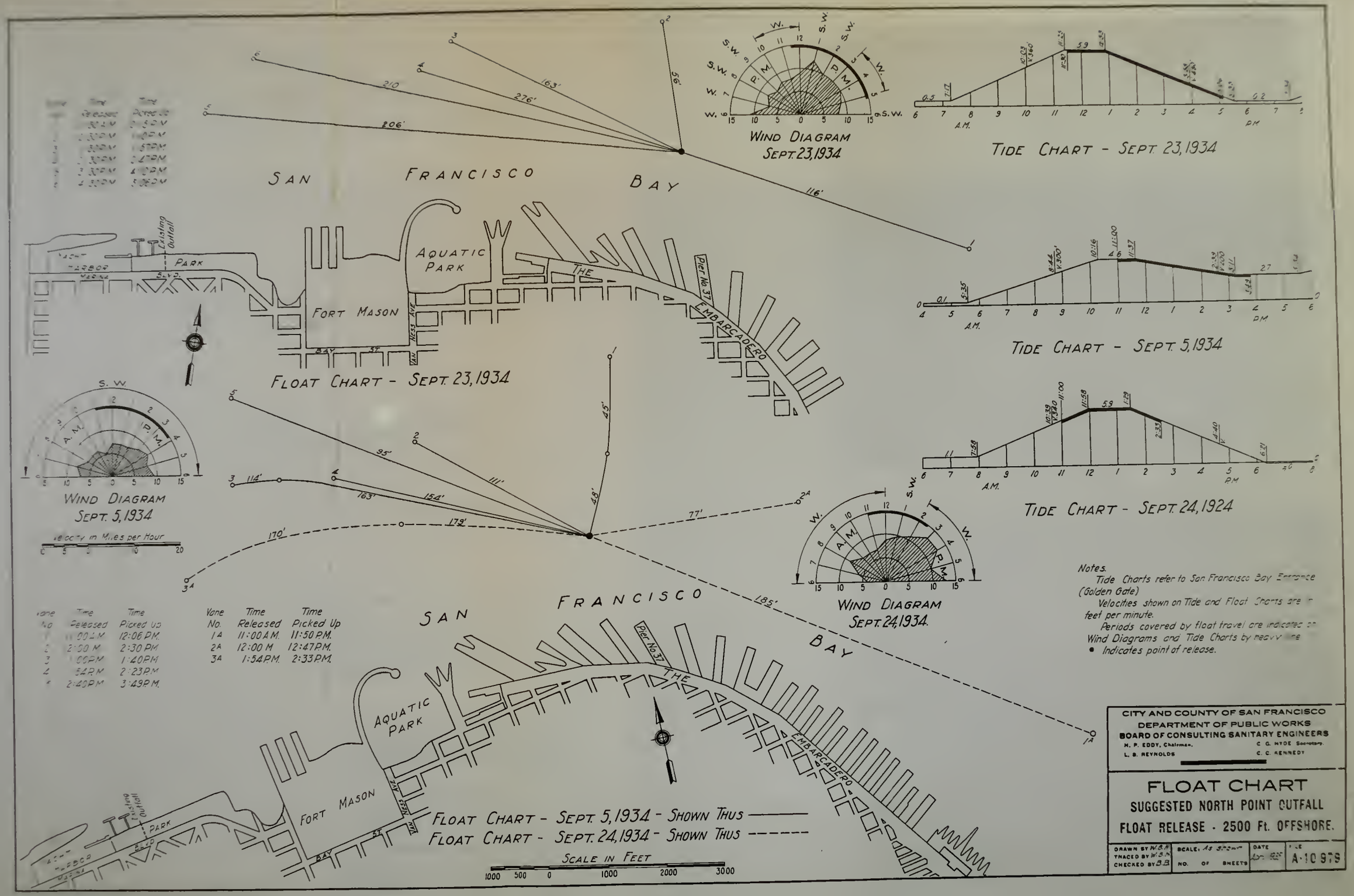
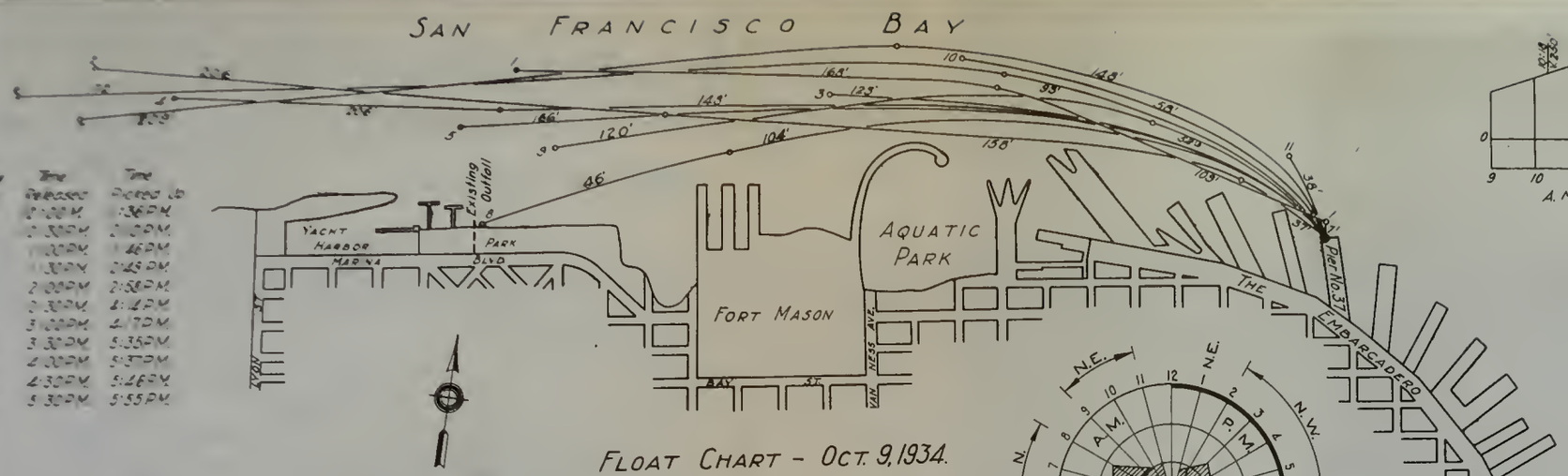
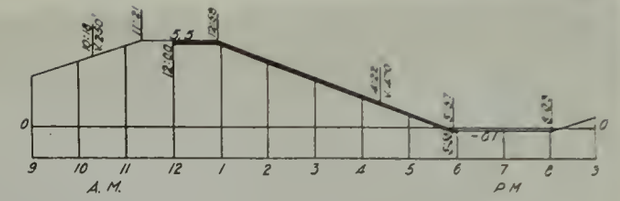

SAN FRANCISCO BAY
WIND DIAGRAM SEPT. 23, 1934
TIDE CHART - SEPT. 23, 1934
TIDE CHART - SEPT. 5, 1934
TIDE CHART - SEPT. 24, 1924
FLOAT CHART - SEPT. 23, 1934
WIND DIAGRAM SEPT. 5, 1934
Velocity in Miles per Hour
WIND DIAGRAM SEPT. 24, 1934.
Notes.
Tide Charts refer to San Francisco Bay Entrance (Golden Gate)
Velocities shown on Tide and Float Charts are in feet per minute.
Periods covered by float travel are indicated on Wind Diagrams and Tide Charts by heavy line
• Indicates point of release.
Vane No. Time Released Time Picked Up
1A 11:00 A.M. 11:50 P.M.
2A 12:00 M 12:47 P.M.
3A 1:54 P.M. 2:33 P.M.
Vane No. Time Released Time Picked Up
1 11:00 A.M. 12:06 P.M.
2 2:00 M 2:30 P.M.
3 1:00 P.M. 1:40 P.M.
4 1:54 P.M. 2:23 P.M.
5 2:40 P.M. 3:49 P.M.
FORT MASON
AQUATIC PARK
THE EMBARCADERO
Pier No. 37
Existing Outfall
MARINA HARBOR
PARK BLVD.
BAY ST.
NORTH BEACH AVE.
FLOAT CHART - SEPT. 5, 1934 - SHOWN THUS
FLOAT CHART - SEPT. 24, 1934 - SHOWN THUS
SCALE IN FEET
CITY AND COUNTY OF SAN FRANCISCO
DEPARTMENT OF PUBLIC WORKS
BOARD OF CONSULTING SANITARY ENGINEERS
M. P. EDDY, Chairman.
C. G. HYDE Secretary.
L. B. REYNOLDS
C. C. KENNEDY
FLOAT CHART
SUGGESTED NORTH POINT OUTFALL
FLOAT RELEASE - 2500 Ft. OFFSHORE.
DRAWN BY
TRACED BY
CHECKED BY
SCALE:
NO. OF SHEETS
DATE
FILE
A-10 979

PLATE 18



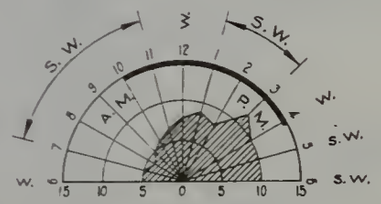
Vane No.	Time Released	Time Picked Up
1	9:00 A.M.	1:36 P.M.
2	9:30 A.M.	2:00 P.M.
3	10:00 A.M.	1:46 P.M.
4	10:30 A.M.	2:45 P.M.
5	2:00 P.M.	2:58 P.M.
6	2:30 P.M.	4:14 P.M.
7	3:00 P.M.	4:17 P.M.
8	3:30 P.M.	5:35 P.M.
9	4:00 P.M.	5:37 P.M.
10	4:30 P.M.	5:46 P.M.
11	5:30 P.M.	5:55 P.M.

FLOAT CHART - OCT. 9, 1934.



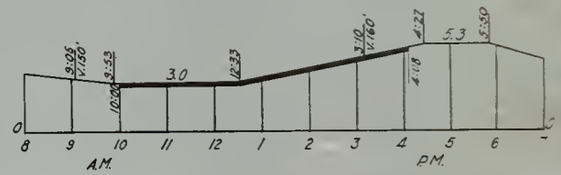
TIDE CHART - OCT. 9, 1934

WIND DIAGRAM
OCT. 9, 1934

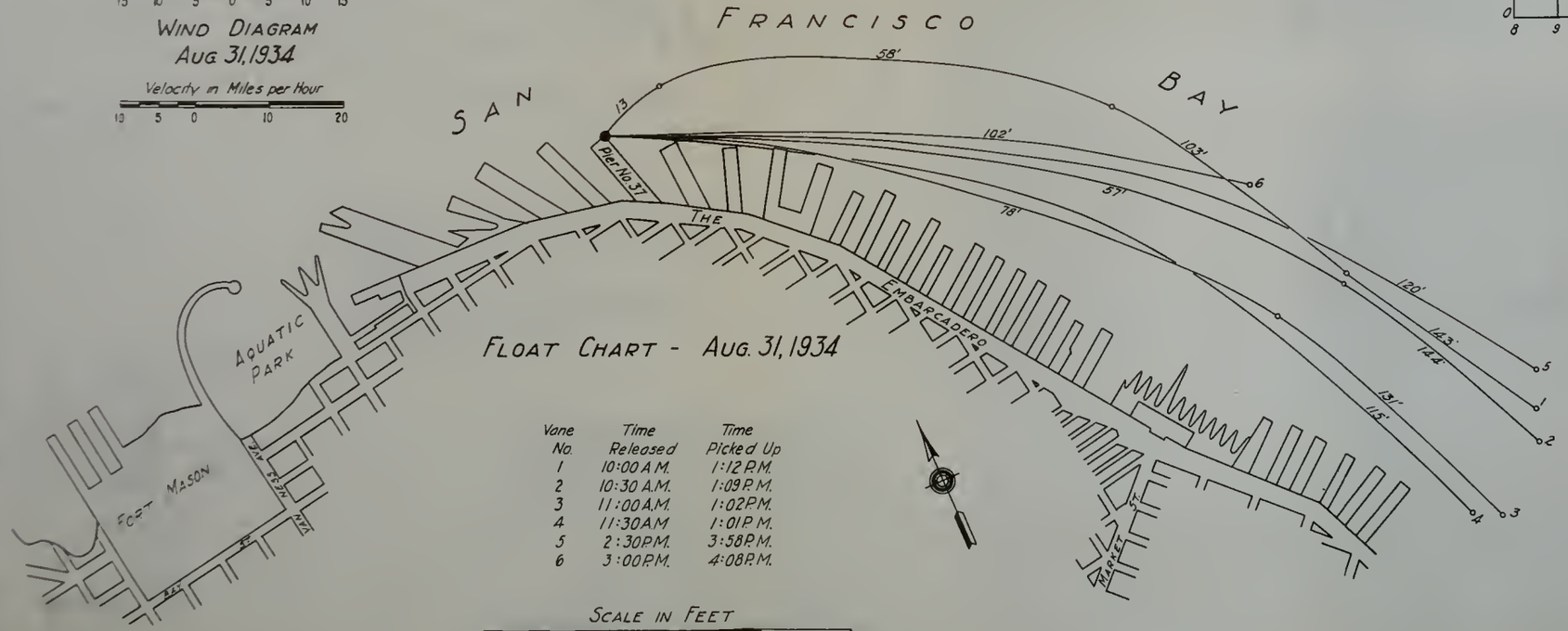


WIND DIAGRAM
AUG. 31, 1934

Velocity in Miles per Hour



TIDE CHART - AUG. 31, 1934



FLOAT CHART - AUG. 31, 1934

Vane No.	Time Released	Time Picked Up
1	10:00 A.M.	1:12 P.M.
2	10:30 A.M.	1:09 P.M.
3	11:00 A.M.	1:02 P.M.
4	11:30 A.M.	1:01 P.M.
5	2:30 P.M.	3:58 P.M.
6	3:00 P.M.	4:08 P.M.

SCALE IN FEET

Notes:

Tide Charts refer to San Francisco Bay Entrance (Golden Gate)

Velocities shown on Tide and Float Charts are in feet per minute.

Periods covered by float travel are indicated on Wind Diagrams and Tide Charts by heavy line.

● Indicates point of release.

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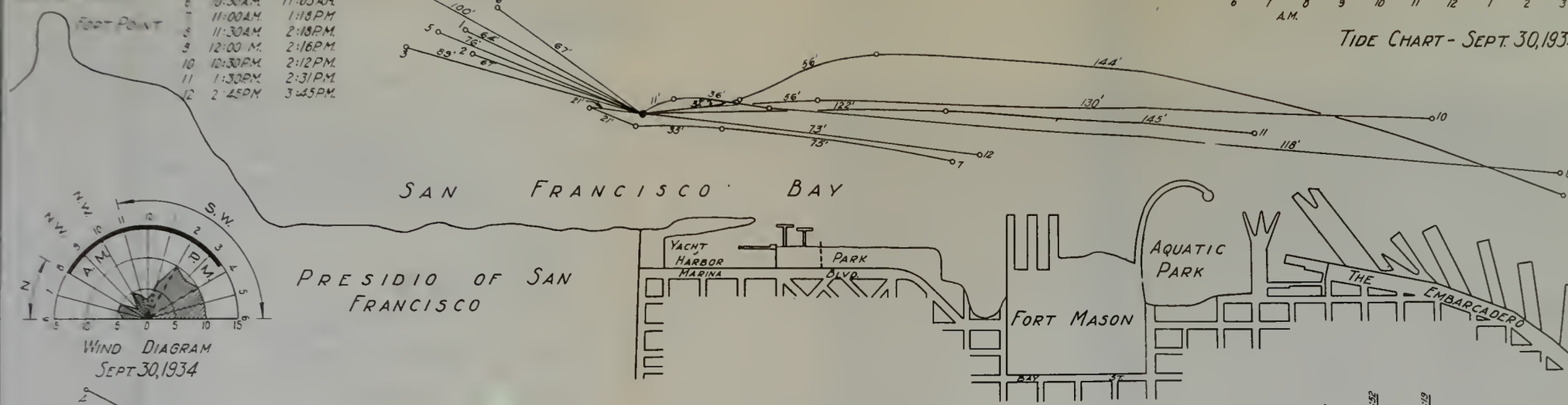
FLOAT CHART
SUGGESTED NORTH POINT OUTFALL
FLOAT RELEASE - END OF PIER 37.

DRAWN BY W.S.A. TRACED BY W.S.K. CHECKED BY B.B.	SCALE: As shown	DATE May 1935	FILE A-10.980

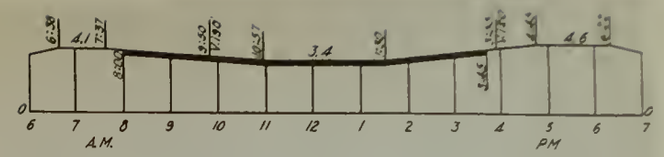
PLATE 19.

Vane No.	Time Released	Time Picked Up
1	8:00 A.M.	8:40 A.M.
2	8:30 A.M.	9:05 A.M.
3	9:00 A.M.	9:36 A.M.
4	9:30 A.M.	10:06 A.M.
5	10:00 A.M.	10:36 A.M.
6	10:30 A.M.	11:05 A.M.
7	11:00 A.M.	1:18 P.M.
8	11:30 A.M.	2:18 P.M.
9	12:00 M.	2:16 P.M.
10	12:30 P.M.	2:12 P.M.
11	1:30 P.M.	2:31 P.M.
12	2:45 P.M.	3:45 P.M.

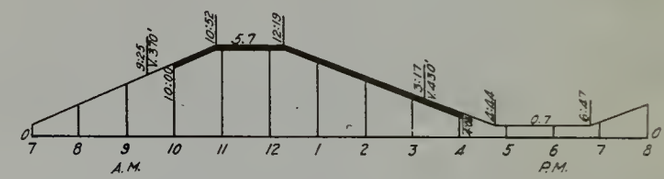


WIND DIAGRAM
SEPT. 30, 1934

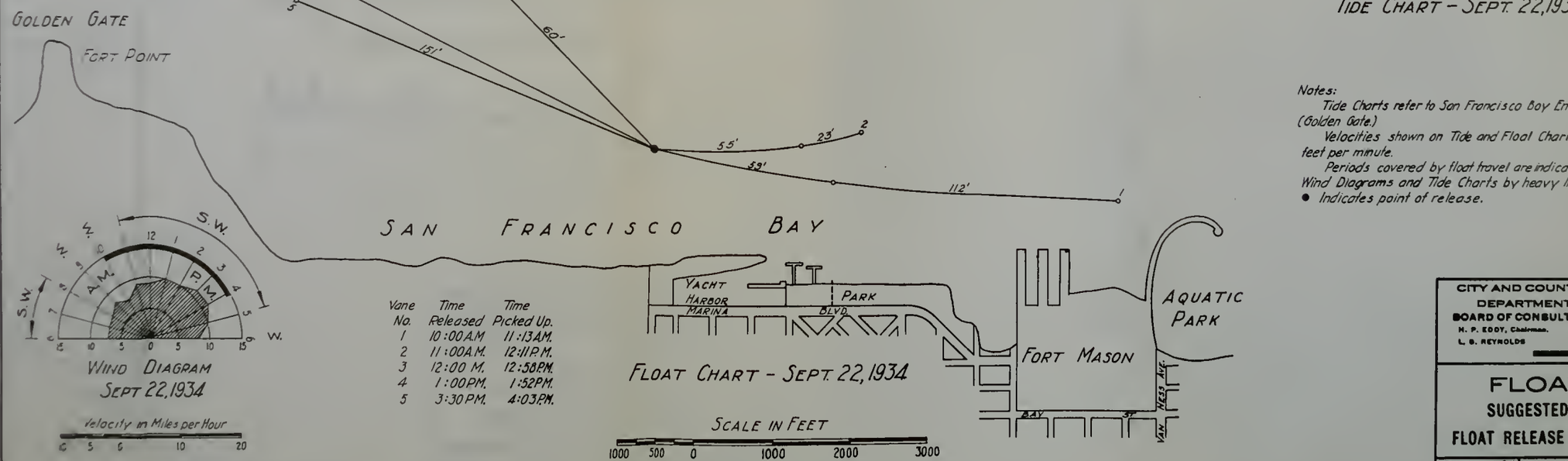
FLOAT CHART - SEPT. 30, 1934



TIDE CHART - SEPT. 30, 1934



TIDE CHART - SEPT. 22, 1934



WIND DIAGRAM
SEPT. 22, 1934

Velocity in Miles per Hour

Vane No.	Time Released	Time Picked Up.
1	10:00 A.M.	11:13 A.M.
2	11:00 A.M.	12:11 P.M.
3	12:00 M.	12:58 P.M.
4	1:00 P.M.	1:52 P.M.
5	3:30 P.M.	4:03 P.M.

FLOAT CHART - SEPT. 22, 1934

SCALE IN FEET

Notes:
Tide Charts refer to San Francisco Bay Entrance (Golden Gate.)
Velocities shown on Tide and Float Charts are in feet per minute.
Periods covered by float travel are indicated on Wind Diagrams and Tide Charts by heavy line.
● Indicates point of release.

CITY AND COUNTY OF SAN FRANCISCO
DEPARTMENT OF PUBLIC WORKS
BOARD OF CONSULTING SANITARY ENGINEERS
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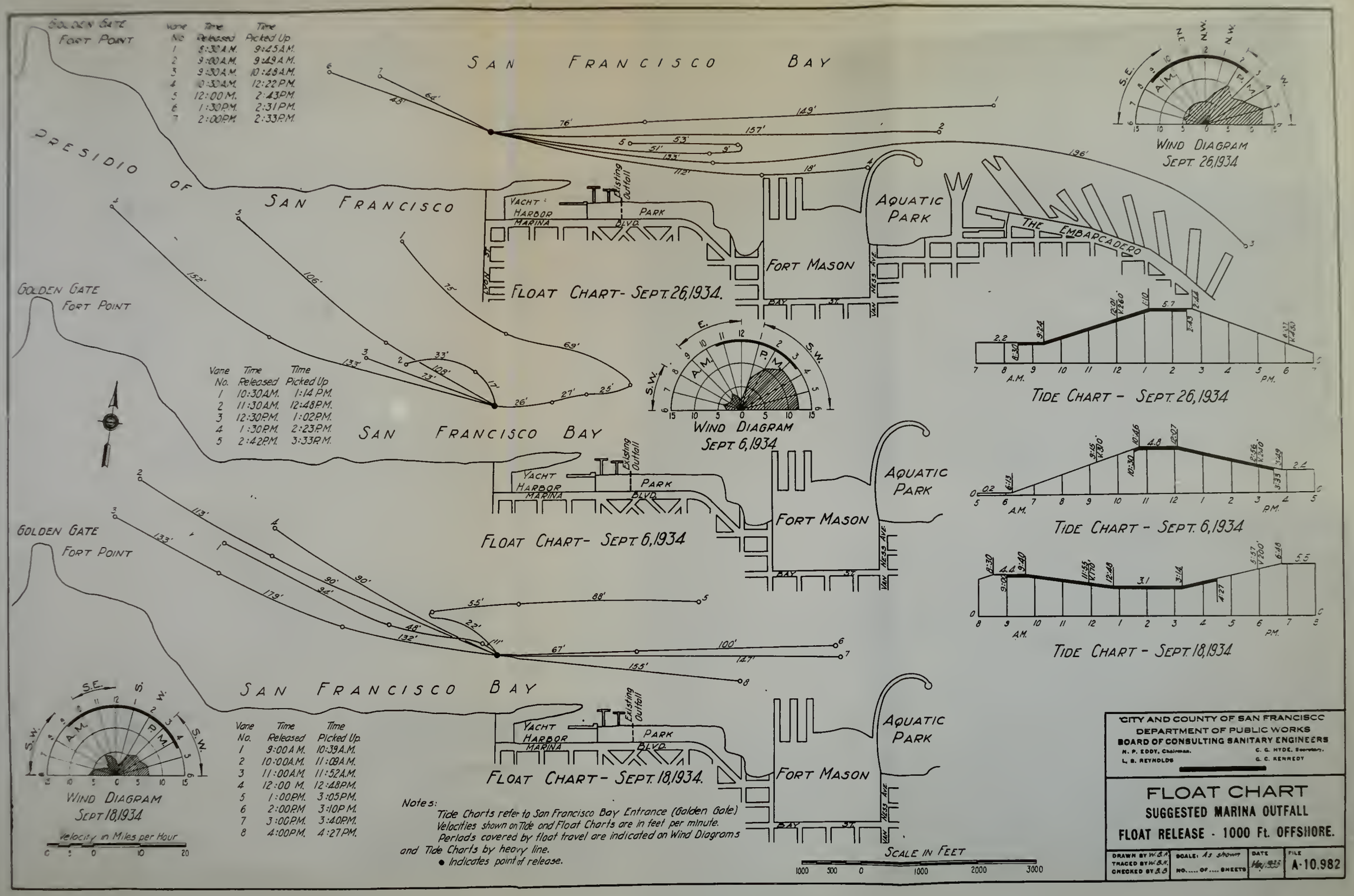
L. S. REYNOLDS C. C. KERNOT

FLOAT CHART
SUGGESTED MARINA OUTFALL
FLOAT RELEASE - 1500 Ft. OFFSHORE.

DRAWN BY W.B.N. TRACED BY W.B.N. CHECKED BY R.P.	SCALE: AS SHOWN NO. ..... OF ..... SHEETS	DATE Apr. 1935	FILE A-10.981

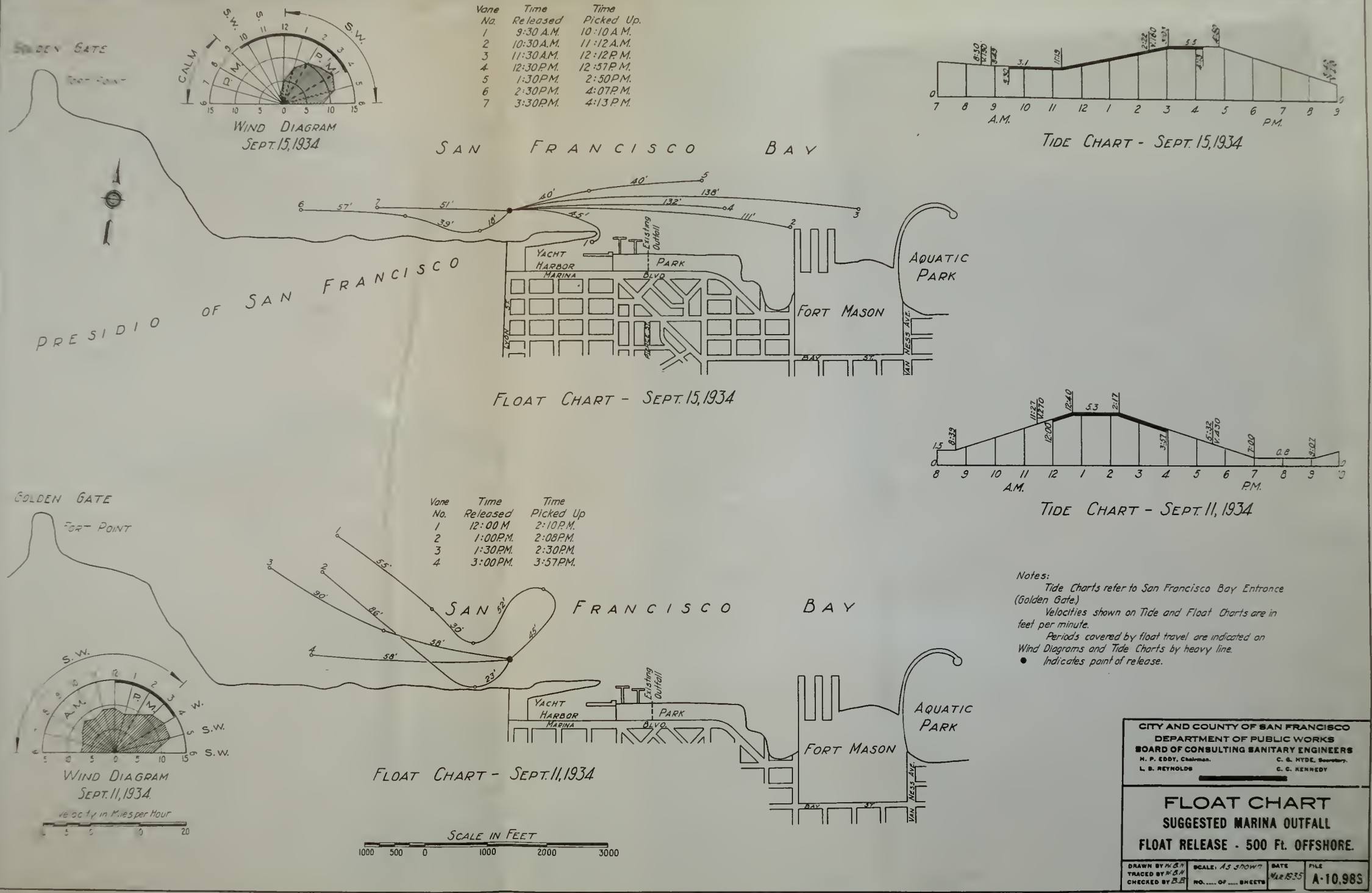
PLATE 20



Vane No.	Time Released	Time Picked Up
1	8:30 A.M.	9:45 A.M.
2	9:00 A.M.	9:49 A.M.
3	9:30 A.M.	10:48 A.M.
4	10:30 A.M.	12:22 P.M.
5	12:00 M.	2:43 P.M.
6	1:30 P.M.	2:31 P.M.
7	2:00 P.M.	2:33 P.M.

Vane No.	Time Released	Time Picked Up
1	10:30 A.M.	1:14 P.M.
2	11:30 A.M.	12:48 P.M.
3	12:30 P.M.	1:02 P.M.
4	1:30 P.M.	2:23 P.M.
5	2:42 P.M.	3:33 P.M.

Vane No.	Time Released	Time Picked Up
1	9:00 A.M.	10:39 A.M.
2	10:00 A.M.	11:08 A.M.
3	11:00 A.M.	11:52 A.M.
4	12:00 M.	12:48 P.M.
5	1:00 P.M.	3:05 P.M.
6	2:00 P.M.	3:10 P.M.
7	3:00 P.M.	3:40 P.M.
8	4:00 P.M.	4:27 P.M.



Vane No.	Time Released	Time Picked Up.
1	9:30 A.M.	10:10 A.M.
2	10:30 A.M.	11:12 A.M.
3	11:30 A.M.	12:12 P.M.
4	12:30 P.M.	12:57 P.M.
5	1:30 P.M.	2:50 P.M.
6	2:30 P.M.	4:07 P.M.
7	3:30 P.M.	4:13 P.M.

Vane No.	Time Released	Time Picked Up
1	12:00 M	2:10 P.M.
2	1:00 P.M.	2:08 P.M.
3	1:30 P.M.	2:30 P.M.
4	3:00 P.M.	3:57 P.M.

Notes:

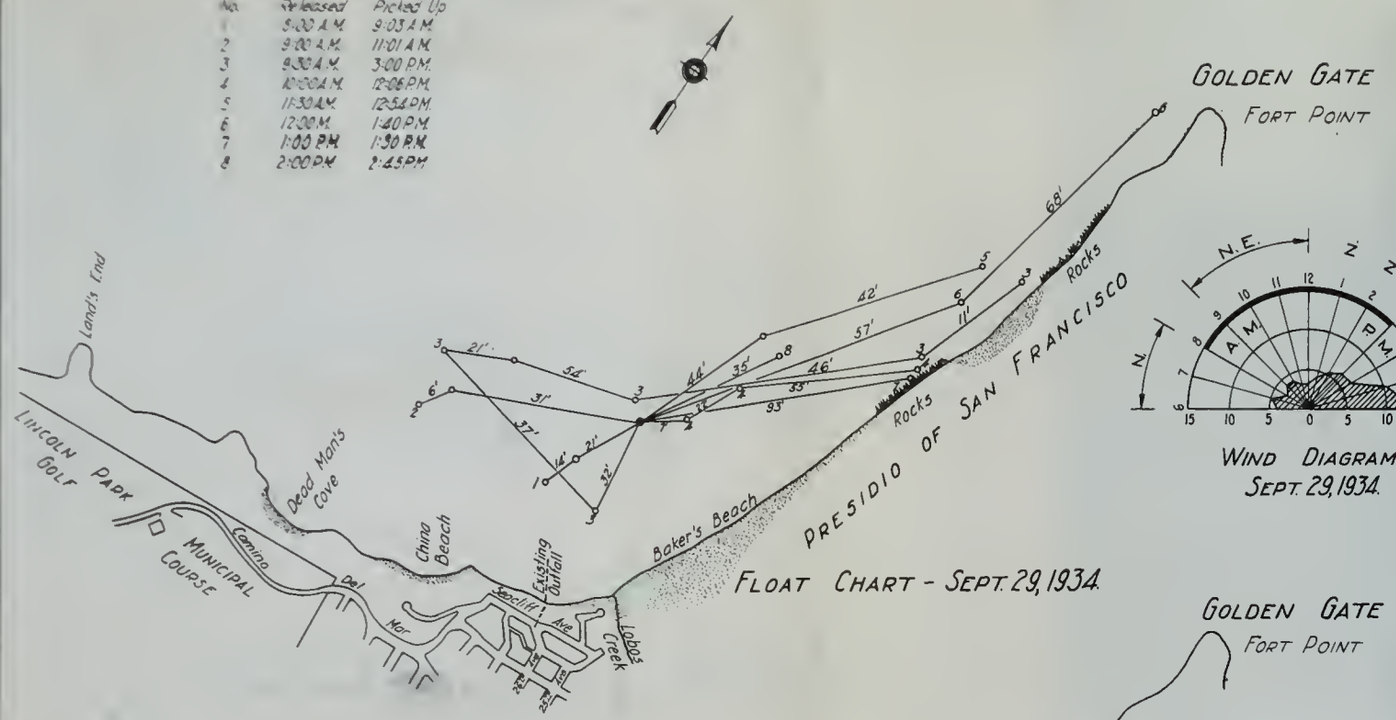
Tide Charts refer to San Francisco Bay Entrance (Golden Gate.)

Velocities shown on Tide and Float Charts are in feet per minute.

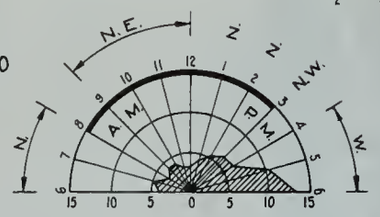
Periods covered by float travel are indicated on Wind Diagrams and Tide Charts by heavy line.

● Indicates point of release.

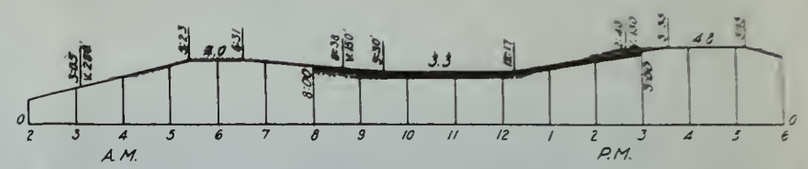
Vane No.	Time Released	Time Picked Up
1	9:00 A.M.	9:03 A.M.
2	9:00 A.M.	11:01 A.M.
3	9:30 A.M.	3:00 P.M.
4	10:00 A.M.	12:06 P.M.
5	11:30 A.M.	12:54 P.M.
6	12:00 M.	1:40 P.M.
7	1:00 P.M.	1:50 P.M.
8	2:00 P.M.	2:45 P.M.



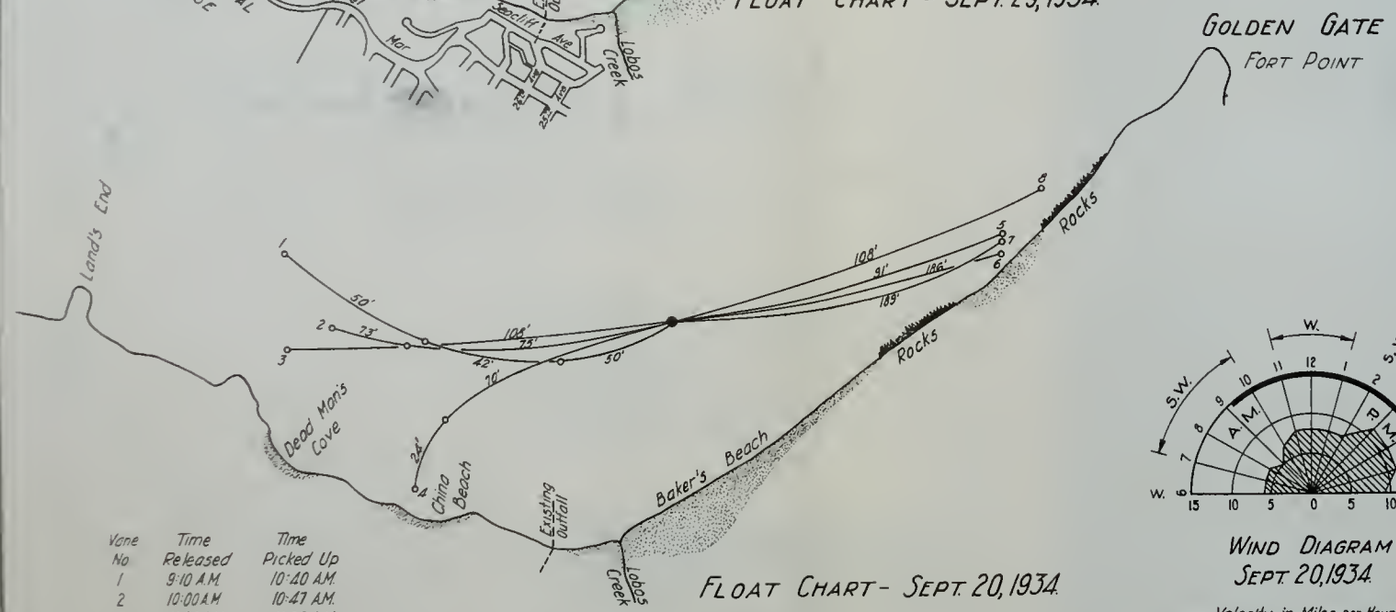
FLOAT CHART - SEPT. 29, 1934.



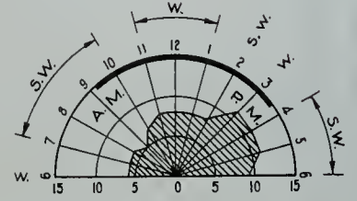
WIND DIAGRAM
SEPT. 29, 1934.



TIDE CHART - SEPT. 29, 1934.



FLOAT CHART - SEPT. 20, 1934.



WIND DIAGRAM
SEPT. 20, 1934.

Velocity in Miles per Hour

10 0 10 20

TIDE CHART - SEPT. 20, 1934.

Notes:

Tide Charts Refer to San Francisco Bay Entrance (Golden Gate).

Velocities shown on Tide and Float Charts are in feet per minute.

Periods covered by float travel are indicated on Wind Diagrams and Tide Charts by heavy line.

● Indicates point of release.

Vane No.	Time Released	Time Picked Up
1	9:10 A.M.	10:40 A.M.
2	10:00 A.M.	10:47 A.M.
3	11:00 A.M.	11:36 A.M.
4	12:00 M.	1:09 P.M.
5	1:00 P.M.	1:38 P.M.
6	2:00 P.M.	2:18 P.M.
7	2:30 P.M.	2:48 P.M.
8	3:00 P.M.	3:37 P.M.

SCALE IN FEET

1000 500 0 1000 2000 3000

CITY AND COUNTY OF SAN FRANCISCO
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L. S. REYNOLDS C. C. KENNEDY

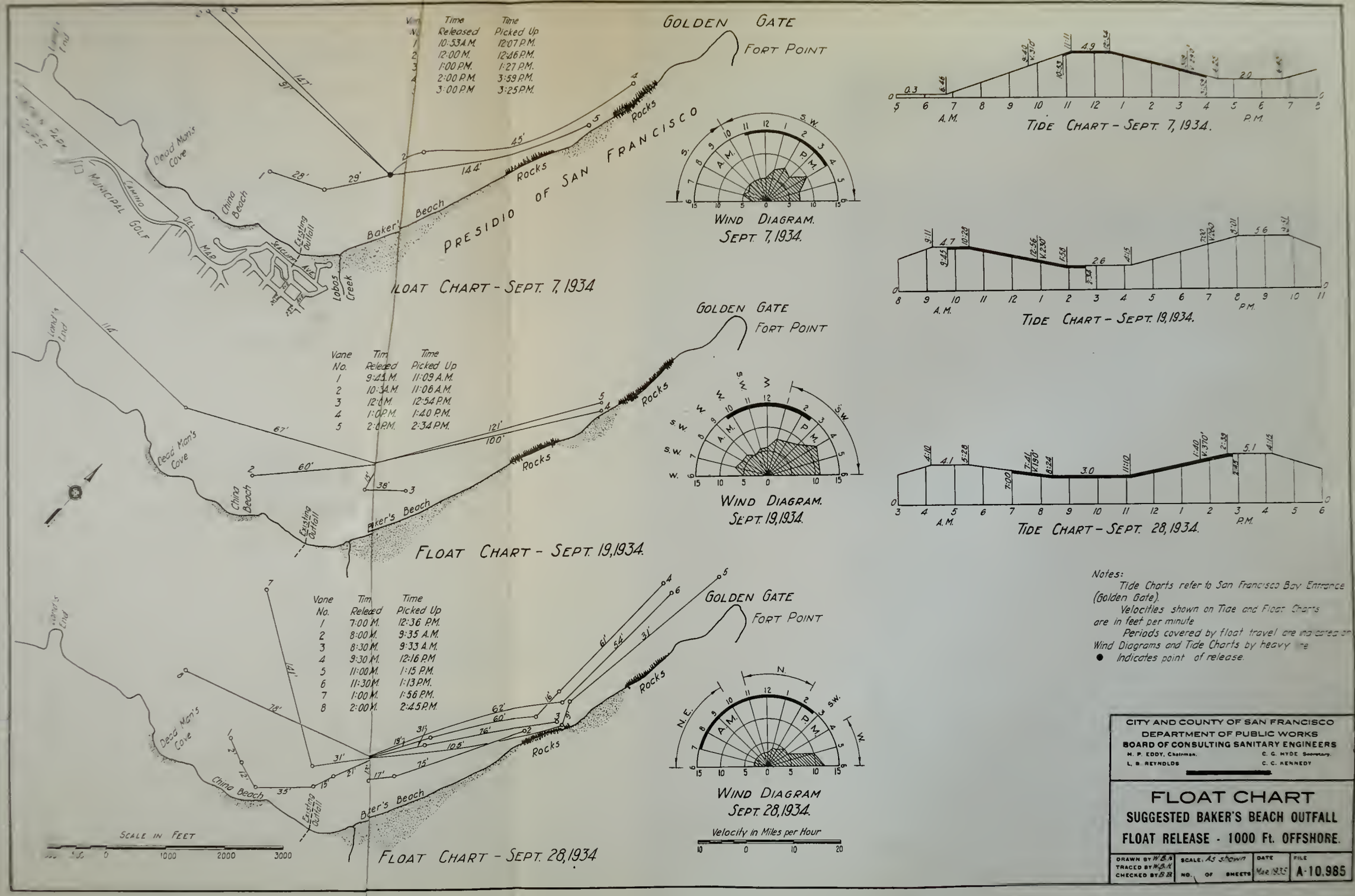
FLOAT CHART

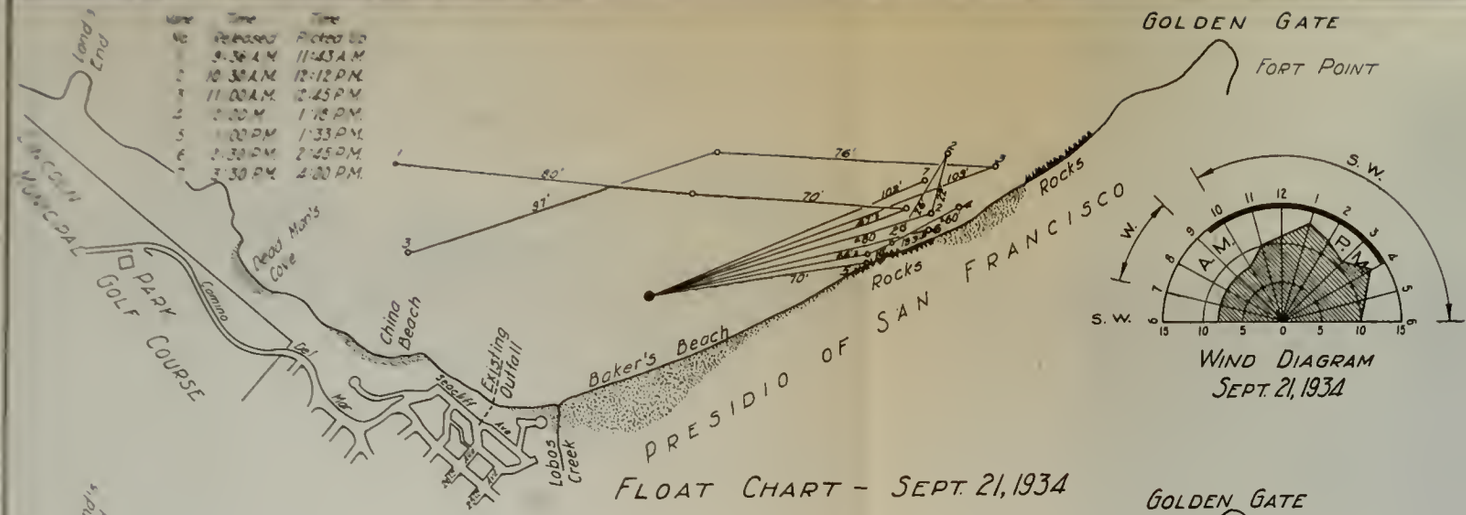
SUGGESTED BAKER'S BEACH OUTFALL

FLOAT RELEASE - 1500 Ft. OFFSHORE.

DRAWN BY W.D.K. TRACED BY W.D.K. CHECKED BY B.D.	SCALE: As shown NO. OF SHEETS	DATE Mar 1935	FILE A-10.984

PLATE 23

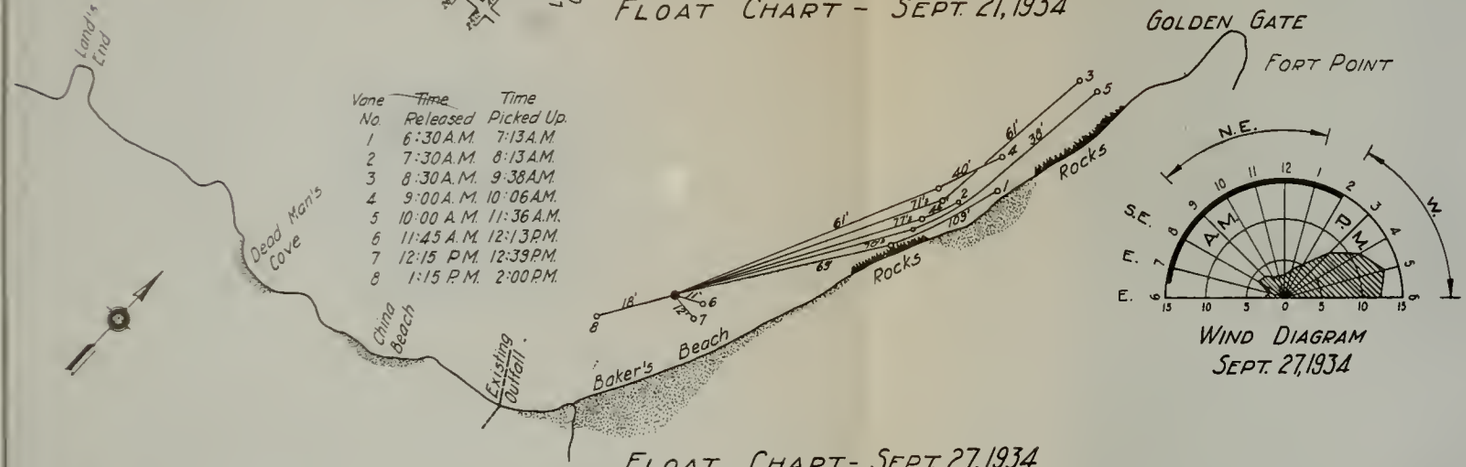

GOLDEN GATE
FORT POINT
PRESIDIO OF SAN FRANCISCO
Dead Man's Cove
China Beach
Baker's Beach
Existing Outfall
Lobos Creek
Rocks
FLOAT CHART - SEPT. 7, 1934
WIND DIAGRAM. SEPT. 7, 1934.
TIDE CHART - SEPT. 7, 1934.
TIDE CHART - SEPT. 19, 1934.
WIND DIAGRAM. SEPT. 19, 1934.
FLOAT CHART - SEPT. 19, 1934.
TIDE CHART - SEPT. 28, 1934.
WIND DIAGRAM SEPT. 28, 1934.
FLOAT CHART - SEPT. 28, 1934
Velocity in Miles per Hour
SCALE IN FEET
Notes:
Tide Charts refer to San Francisco Bay Entrance (Golden Gate).
Velocities shown on Tide and Float Charts are in feet per minute
Periods covered by float travel are indicated on Wind Diagrams and Tide Charts by heavy line
● Indicates point of release.
CITY AND COUNTY OF SAN FRANCISCO
DEPARTMENT OF PUBLIC WORKS
BOARD OF CONSULTING SANITARY ENGINEERS
M. P. EDDY, Chairman.
C. G. HYDE Secretary.
L. B. REYNOLDS
C. C. KENNEDY
FLOAT CHART
SUGGESTED BAKER'S BEACH OUTFALL
FLOAT RELEASE - 1000 Ft. OFFSHORE.
DRAWN BY W.B.A.
TRACED BY W.S.K.
CHECKED BY B.B.
SCALE: As shown
NO. OF SHEETS
DATE Mar 1935
FILE A-10.985
PLATE 24



Float Chart - Sept. 21, 1934

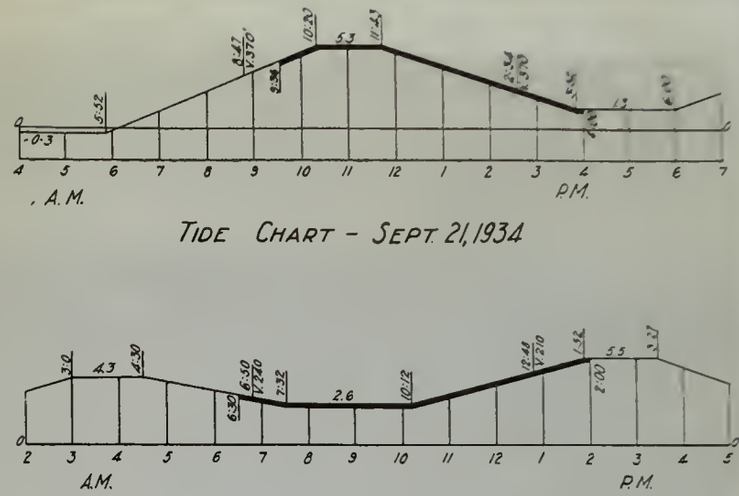
Wind Diagram
Sept. 21, 1934

Tide Chart - Sept. 21, 1934

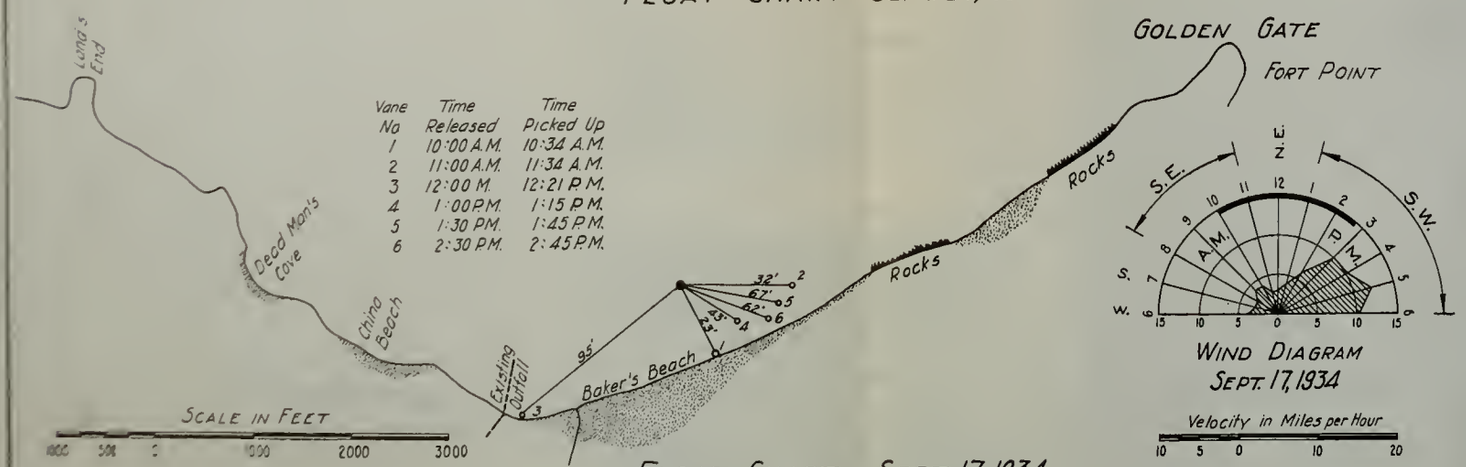


Float Chart - Sept. 27, 1934

Wind Diagram
Sept. 27, 1934



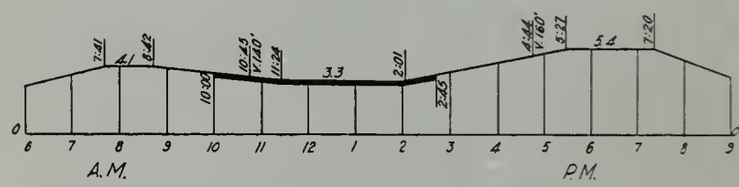
Tide Chart - Sept. 27, 1934



Float Chart - Sept. 17, 1934

Wind Diagram
Sept. 17, 1934

Velocity in Miles per Hour
10 5 0 10 20



Tide Chart - Sept. 17, 1934

Notes:
Tide Charts refer to San Francisco Bay Entrance (Golden Gate.)
Velocities shown on Tide and Float Charts are in feet per minute.
Periods covered by float travel are indicated on Wind Diagrams and Tide Charts by heavy line.
● Indicates point of release.

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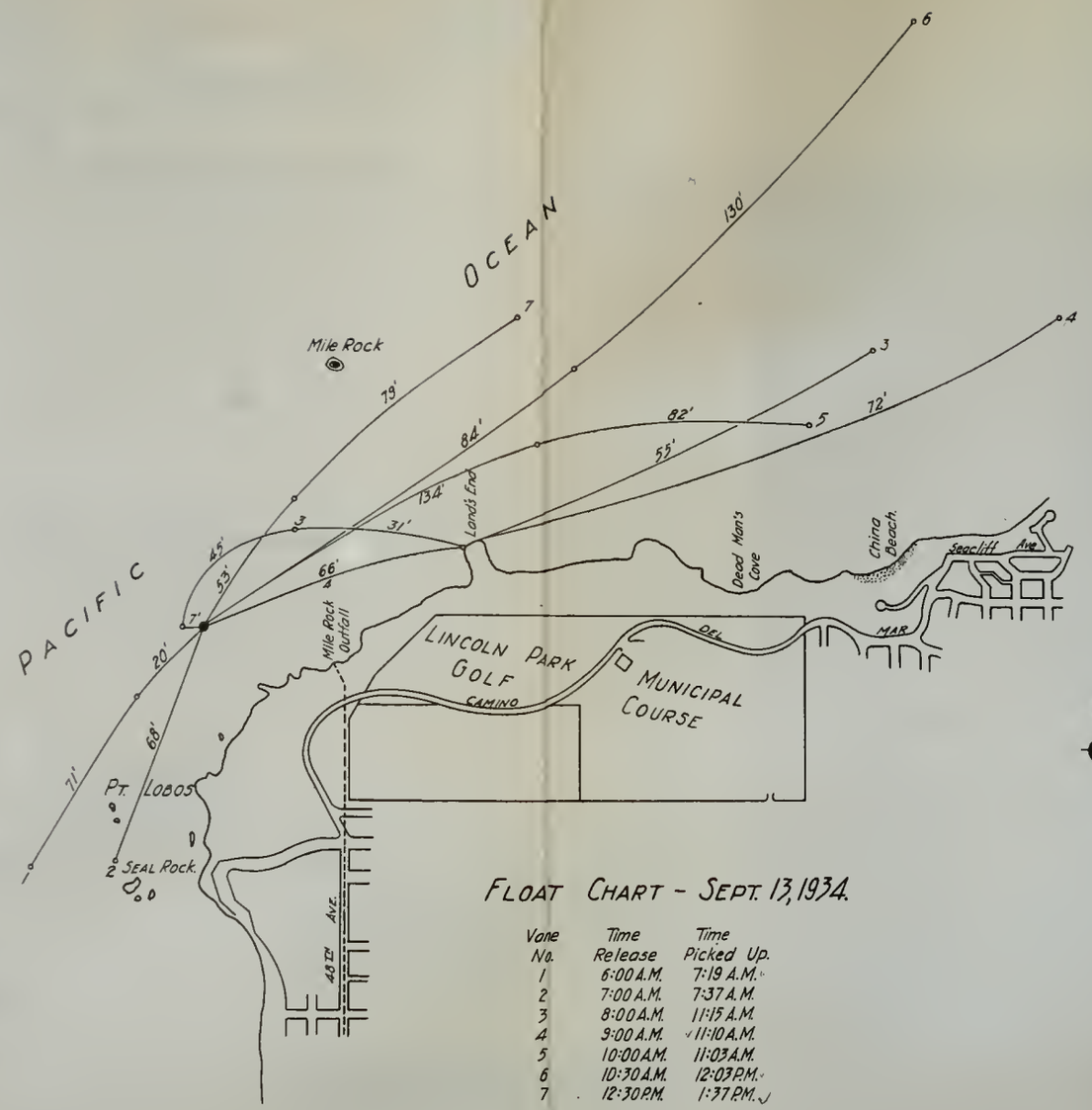
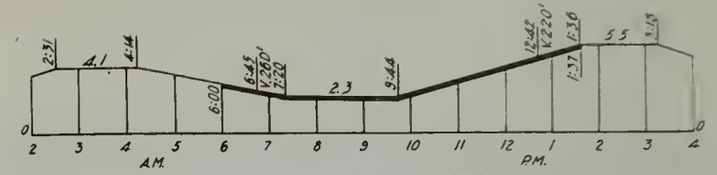
FLOAT CHART
SUGGESTED BAKER'S BEACH OUTFALL
FLOAT RELEASE - 500 Ft. OFFSHORE.

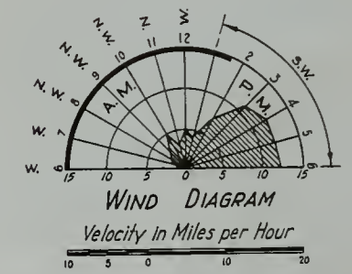
DRAWN BY N.B.H. TRACED BY N.B.H. CHECKED BY E.B.	SCALE: NO. OF SHEETS	DATE Mar 1935	FILE A-10 986

PLATE 25





TIDE CHART - SEPT. 13, 1934.



WIND DIAGRAM

FLOAT CHART - SEPT. 13, 1934.

Vane No.	Time Release	Time Picked Up.
1	6:00 A.M.	7:19 A.M.
2	7:00 A.M.	7:37 A.M.
3	8:00 A.M.	11:15 A.M.
4	9:00 A.M.	11:10 A.M.
5	10:00 A.M.	11:03 A.M.
6	10:30 A.M.	12:03 P.M.
7	12:30 P.M.	1:37 P.M.

SCALE IN FEET

1000 500 0 1000 2000 3000

Notes:

Tide Charts refer to San Francisco Bay Entrance (Golden Gate).

Velocities shown on Tide and Float Charts are in feet per minute.

Periods covered by float travel are indicated on Wind Diagrams and Tide Charts by heavy line.

• Indicates point of release.

CITY AND COUNTY OF SAN FRANCISCO
DEPARTMENT OF PUBLIC WORKS
BOARD OF CONSULTING SANITARY ENGINEERS
H. P. EDDY, Chairman. C. G. HYDE, Secretary.
L. B. REYNOLDS C. C. KENNEDY

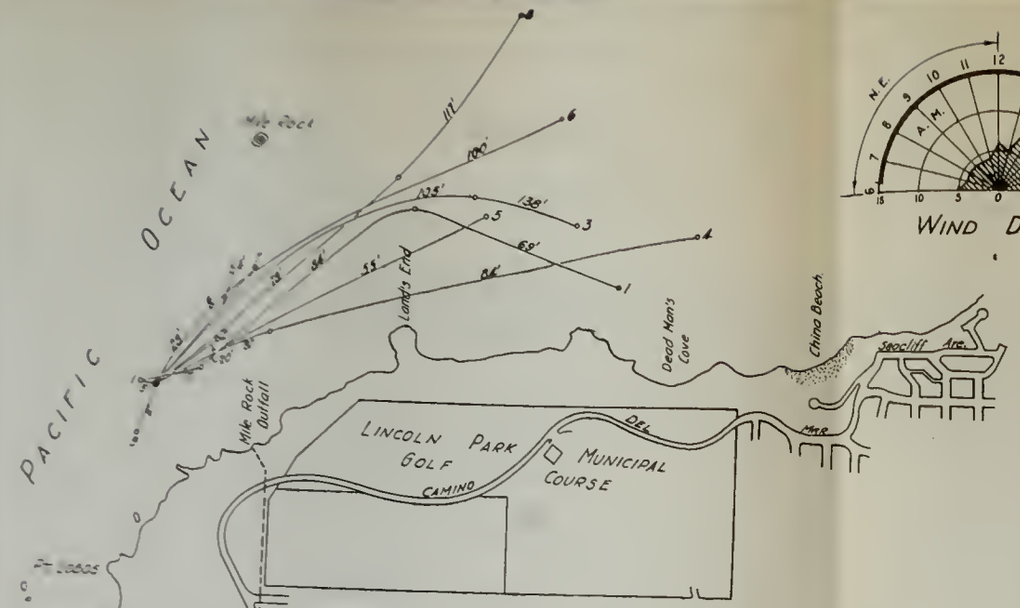
FLOAT CHART

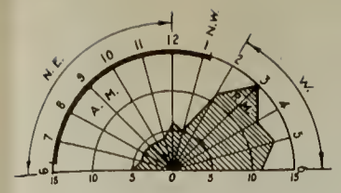
SUGGESTED MILE ROCK OUTFALL

FLOAT RELEASE - 1500 Ft. OFFSHORE.

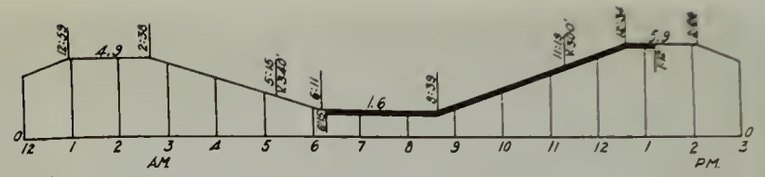
DRAWN BY W.B.R. TRACED BY W.B.R. CHECKED BY B.A.	SCALE: NO. OF SHEETS	DATE Mar 1935	FILE A-10.987

PLATE 26.





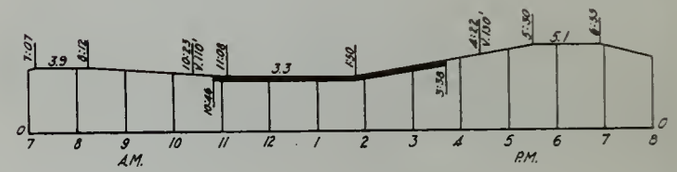
WIND DIAGRAM



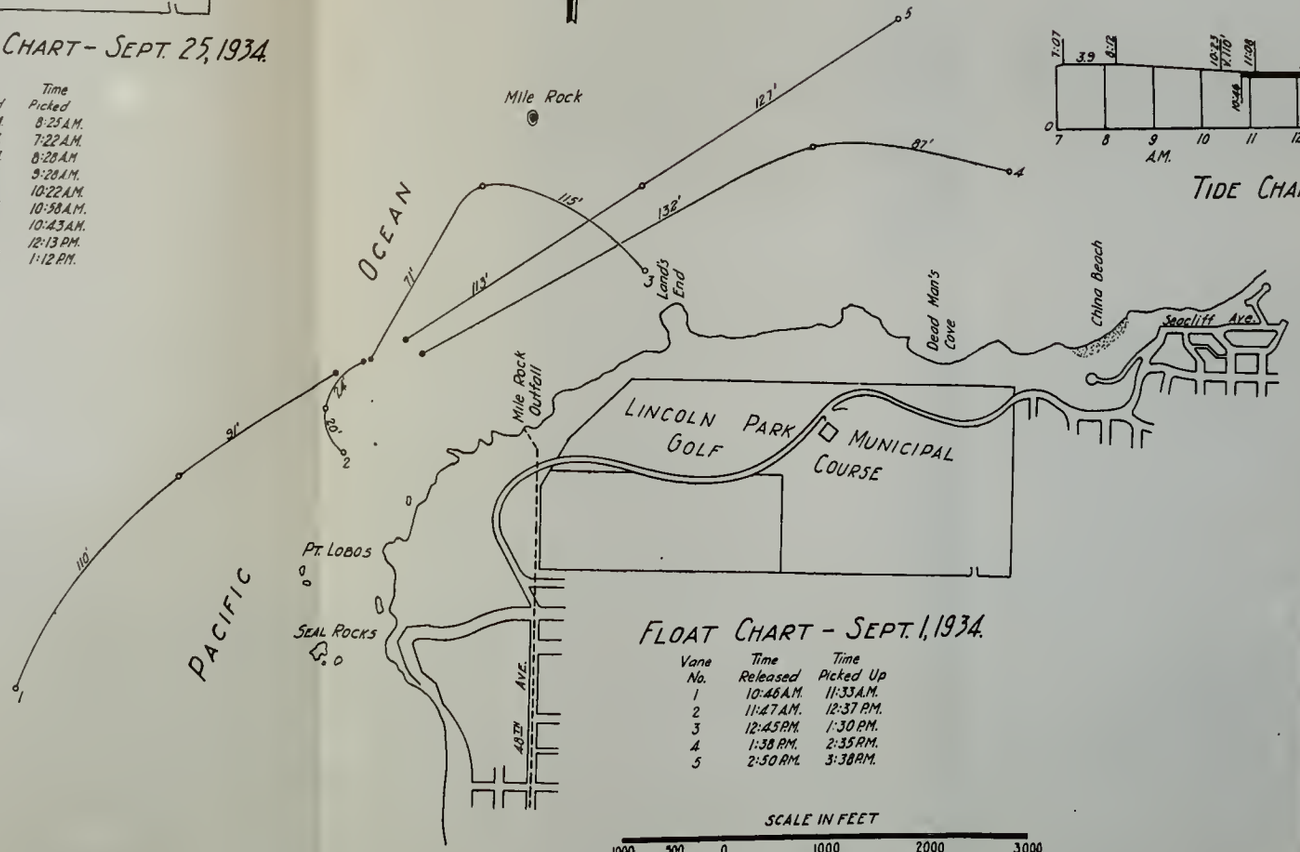
TIDE CHART - SEPT. 25, 1934.

FLOAT CHART - SEPT. 25, 1934.

Vane No.	Time Released	Time Picked
1	6:15 A.M.	8:25 A.M.
2	6:45 A.M.	7:22 A.M.
3	7:45 A.M.	8:28 A.M.
4	8:15 A.M.	9:28 A.M.
5	9:15 A.M.	10:22 A.M.
6	9:45 A.M.	10:58 A.M.
7	10:15 A.M.	10:43 A.M.
8	11:15 A.M.	12:13 P.M.
9	11:45 A.M.	1:12 P.M.



TIDE CHART - SEPT. 1, 1934.

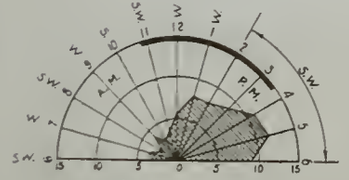


FLOAT CHART - SEPT. 1, 1934.

Vane No.	Time Released	Time Picked Up
1	10:46 A.M.	11:33 A.M.
2	11:47 A.M.	12:37 P.M.
3	12:45 P.M.	1:30 P.M.
4	1:38 P.M.	2:35 P.M.
5	2:50 P.M.	3:38 P.M.

SCALE IN FEET

1000 500 0 1000 2000 3000



WIND DIAGRAM

Velocity in Miles per Hour

0 5 0 10 20

Notes:

Tide Charts refer to San Francisco Bay Entrance (Golden Gate.)

Velocities shown on Tide and Float Charts are in feet per minute.

Periods covered by float travel are indicated on Wind Diagrams and Tide Charts by heavy line.

● Indicates point of release

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FLOAT CHART

SUGGESTED MILE ROCK OUTFALL

FLOAT RELEASE - 1000 Ft. OFFSHORE.

DRAWN BY W.S.H. TRACED BY W.S.H. CHECKED BY E.B.	SCALE: As shown NO. ... OF SHEETS	DATE 4/12/1935	FILE A-10,988

PLATE 27.

Table 9

Station	Distance Off Shore	Date 1934	Period Covered Hours	Predicted Height of Tide: High to Low	Predicted Height of Tide: Low to High	Current Direction and Velocity (6 AM – 6 PM)	Current Turns: Seaward	Current Turns: Bayward	Wind Direction	Remarks
PIER 37	* 950	9-31	0.2	–	2.3	SE AV 100'; 58'; 130'; 110'		First of Low Slack	SW & W	Wind generally off shore normal to float travel
	* 950	10-9	6.0	5.6	–	100'; 155'; W. AV 100'; 40'	Middle of High Slack	First 1/4± of Low Slack	N.E.; N.W.	Athwart direction of float travel toward shore: first favoring travel, later hindering travel
	2500	9-24	3.6	6.0	4.8	185'; 77'; 175'; E AV 131'	Middle of High Slack		W	For bayward floats, wind in general direction of float travel. For seaward floats, wind opposed to direction of float travel
	2500	9-5	4.8	1.9	–	46'; 154'; 95'; N.W. AV 110'	Middle of High Slack		S.W. about Normal to Floats.	At turn of current floats tend to go northward out into bay and Golden Gate Strait
	2500	9-23	5.6	5.7	–	115'; 56'; 276'; 210'; N.W. AV 182'	Middle of High Slack		W. & S.W.	For bayward floats, wind in general direction of float travel. For seaward floats, wind athwart and against direction of float travel
MARINA	500	9-1	4.0	4.5	3.8	45'; 50'; 90'; 58'; W. & N.W. AV. 62'	First of High Slack		S.W. off Shore	Wind about normal off shore for seaward floats.
	500'	9-15	6.7	–	2.4	E AV 93'; 45'; 138'; 40'; 30'; 54'; W. AV 42'	3/4 of Flood		S.W.	For bayward floats wind athwart and favoring travel. For seaward floats, wind athwart and hindering travel
	500'	9-18	7.4	1.3	2.4	70'; 155'; 22'; E AV 119'; 77'; 155'; N.W. AV 87'		First of Low Slack	Variable - S.E., S.W., S.W.	For seaward floats wind athwart, offshore and favoring travel. For bayward floats wind behind and athwart, offshore and favoring travel.
	1000'	9-6	5.2	2.4	4.6	26'; 17'; 142'; 107'; N.W. AV 82'	Middle of High Slack		E. & S.W.	For bayward floats wind against direction of travel. For seaward floats wind offshore normal to direction of travel
	1000'	9-26	6.8	–	3.5	N.W. - AV 110'; 76'; 160'; 51'; 53'; N.W.	1/3 of High Slack		Variable - S.E. to N.W. & W.	For bayward floats wind variable, first off shore and then in direction of travel. For seaward floats wind opposed to direction of travel.
	1500'	9-22	6.7	5.0	5.6	82'; 38'; 60'; 160'; N.W. AV. 131'; 151'; E AV 60'	Middle of High Slack		W. & S.W.	Wind generally in direction of bayward travel of floats and athwart offshore and against direction of travel of seaward floats.
	500	9-30	7.7	0.7	1.2	65'; 95'; 21'; 20'; E AV 85'; 140'; 75'; N.W. AV 65'		First of Low Slack	N.W. & S.W.	Wind generally against direction of travel of seaward floats and athwart bayward floats offshore and aiding velocity
BAKER'S BEACH	500'	9-17	5.3	0.8	2.1	All floats towards shore within 1500' - 2000' of point of release			S.E., N.E., S.W.	Winds variable, first offshore and later parallel with shore.
	500'	9-27	7.4	–	2.9	70'; N.E. AV 44'; 12'; 18'	Middle of Flood		N.E. & W.	Wind variable, mostly against bayward travel and in direction of seaward travel. All floats close to shore at 2,800'.
	500'	9-21	6.3	4.0	5.6	47'; 70'; 90'; 60'; N.E. AV 180'; 190'; 100'; N.E. AV 55'; 100'			W. & S.W.	Wind generally in direction of float travel. Three floats moved seaward after travelling bayward and with no apparent reason. All floats bayward close to shore at 3,200'.
	1000'	9-28	6.0	1.1	2.1	20'; 25'; N.E. AV 45'; 60'; 30'; 140'; W. AV. 85'	Middle of Flood	End of Ebb	N.E. & N.	Wind in general toward shore, normal to seaward floats and tending to retard bayward floats. All bayward floats close to shore at 3200' and 1 seaward float at 2,000'.
	1000'	9-19	6.4	2.1	–	70'; W; 38'; N.E. AV 86'; 121'		Middle of Ebb	S.W. & W.	Wind normal and offshore to seaward floats and in direction of travel of bayward floats. Bayward floats close to shore about 4,000' or less, from point of release.
	1000'	9-7	5.1	2.9	–	28'; 147'; 69'; N.E.; N.W. AV 87'		First 1/3 of Ebb	S.W.	Wind offshore normal to seaward floats and in direction of travel of bayward floats. Bayward floats close to shore about 3,200' from point of release.
	1500'	9-20	6.8	3.1	5.5	50'; 108'; 48'; 91'; N.E. AV 123'; 190'; 108'; S.W. AV 65'		Middle of Ebb.	W. & S.W.	Wind against float direction seaward and approximate in direction of float travel bayward. One seaward and all bayward floats approached closely to shore about 3,200' from point of release.
	1500'	9-29	7.0	0.7	1.5	6'; S.W. AV 23'; 40'; 50'; 90'; N.E. AV 65'		First 1/3 of Low Slack	N. & N.E. Toward Shore	Three floats close to shore 3,000' from point of release
MILE ROCK	1000'	9-1	4.9	–	1.8	S.W. AV. 61'; 100'; 22'; 70'; N.E. AV 105'; 127'		First 1/3 of Low Slack	W. & S.W.	Wind against float direction seaward and in direction of float travel bayward.
	1000'	9-25	7.1	–	4.3	S.W. 5'; N.E. AV 95'; 75'; 110'; 90'; 6'; S.W.	End 1/3 of Flood	First of Low Slack	N.E.	Wind in direction of floats seaward and against float travel bayward.
	1500'	9-13	7.9	–	3.2	S.W. AV 56'; 45'; 66'; 55'; 130'; 65'; N.E. AV 79'		Middle of Low Slack	N.W. to N. Toward Shore	Current closer to shore at end of ebb and beginning of flood. Two floats apparently struck Land's End

LEGEND: Bayward Movement; Seaward Movement

Notes: The directions shown for current movements are general tendencies.
The velocities shown for current movements are averages.
In some individual cases considerable variation was noted from the assumed directions and velocities.
Refer to Plates 18-27 for Float Charts.
* End of Pier 37.

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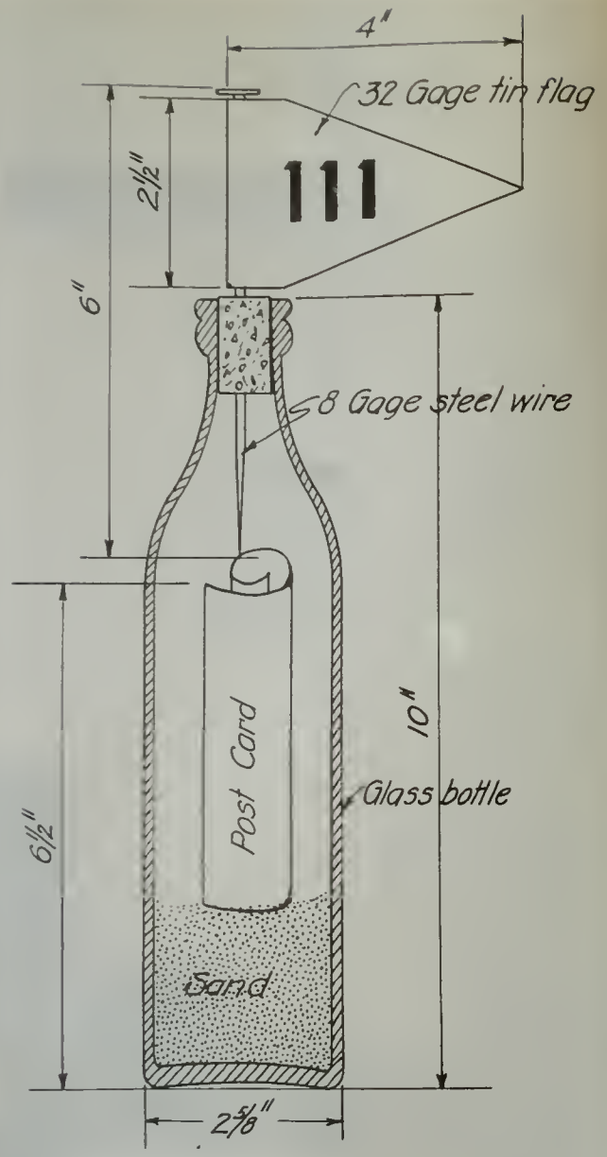
SUMMARY OF FLOAT MOVEMENTS

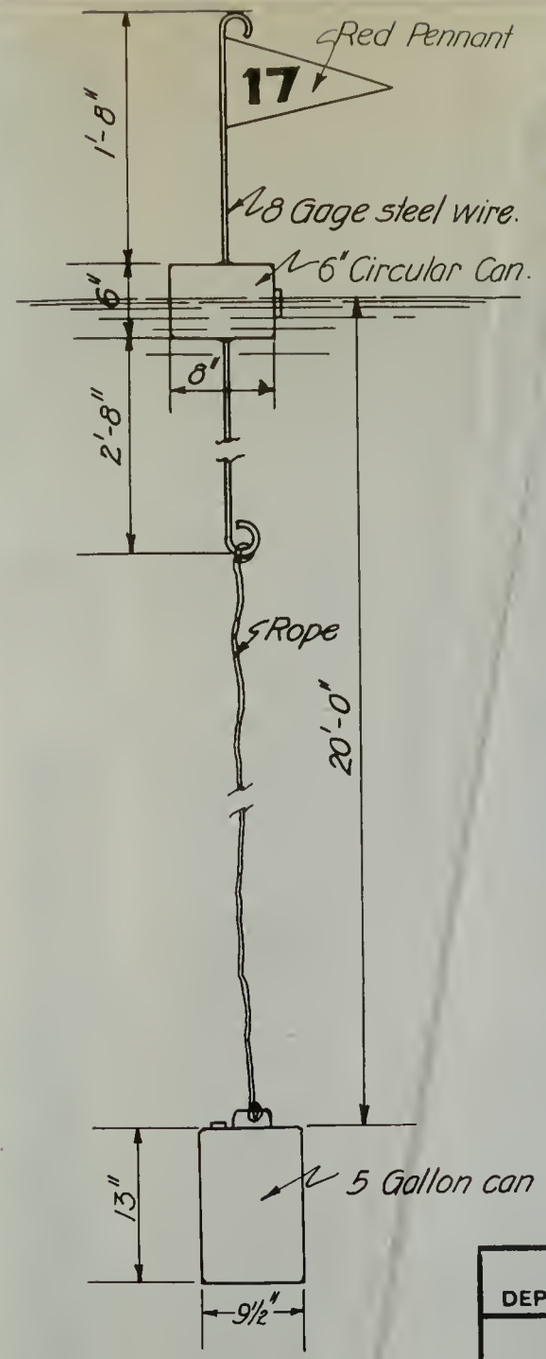
AUGUST - OCTOBER, 1934

DRAWN BY RWJ TRACED BY RWJ CHECKED BY BB | SCALE: NO. ..... OF ..... SHEETS | DATE May 3 1935 | FILE A-10,989

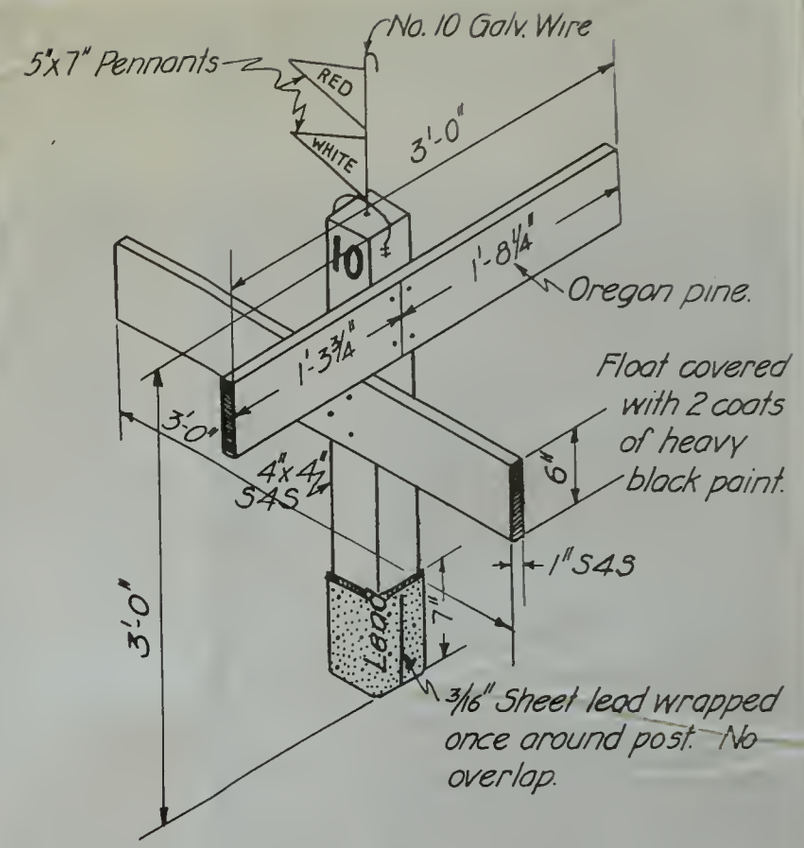
PLATE 26



BOTTLE FLOAT



DEEP SEA OR
SUB-SURFACE FLOAT



LARGE SURFACE FLOAT

Diagram 15

CITY AND COUNTY OF SAN FRANCISCO
DEPT. OF PUBLIC WORKS - BOARD OF CONSULTING SANITARY ENGINEERS

FLOATS USED FOR CURRENT STUDIES.

DRAWN BY R.W.J. TRACED BY R.W.J. CHECKED BY B.B.	SCALE: NO. ---- OF ---- SHEETS	DATE May, 6th, 1935.	FILE L-10,990

PLATE 29

Plate 30

FLOATS USED FOR CURRENT STUDIES.
A-Surface B-Subsurface C-Bottle D-Deep Can

2-21-35
A-4489

Table 10

RECORD OF BOTTLE FLOATS RELEASED FROM MILE ROCK, BAKER'S BEACH, LYON STREET AND PIER NO. 37 AT VARIOUS DISTANCES FROM SHORE

For Locations of Release and Pick Up see Table 32

RELEASED				PICKED UP		
No.	Date	Time	Location	Date	Time	Location
1						
2						
3						
4	9-29-34	11:35 A.M.	1000' off Bakers Beach	9-29-34	12:00 A.M.	Near Albany
5	"	11:45 A.M.	Pier No. 37	9-29-34	11:50 A.M.	Mobile Pt.-Richmond
6	"	12:55 A.M.	" " "	9-11-34	9:00 A.M.	Alameda Mole
7						
8						
9	9-29-34	1:45 P.M.	Pier No. 37	9-29-34	3:35 P.M.	Angel Island
10	"	2:00 P.M.	" " "	9-3-34	10:00 A.M.	South Oakland Estuary
11	"	2:05 P.M.	" " "	9-29-34	11:00 A.M.	Bakers Beach
12	9-3-34	10:00 A.M.	" " "	9-1-34	10:25 A.M.	Oakland Estuary
13	"	10:05 A.M.	" " "	9-29-34	12:45 P.M.	S.P. Dock #2-Oak Mole
14	"	10:20 A.M.	" " "			
15	"	10:40 A.M.	" " "			
16	"	10:50 A.M.	" " "			
17	"	11:00 A.M.	" " "	9-8-34	1:00 P.M.	Oakland Terminal
18	"	11:00 A.M.	" " "	9-2-34	1:00 P.M.	Yerba Buena Island
19	"	11:30 A.M.	" " "	9-1-34	8:30 A.M.	Oakland Mole
20	"	11:40 A.M.	" " "	9-3-34	6:00 A.M.	Alameda Soap Wks
21	"	11:50 A.M.	" " "			
22	"	12 Noon	" " "	9-2-34	11:00 A.M.	Yerba Buena Island
23	"	12:10 P.M.	" " "	9-2-34	7:45 A.M.	Ft. of Broadway-Oak'd
24	"	12:15 P.M.	" " "	9-1-34	12:25 P.M.	Key Route Pier
25	"	12:30 P.M.	" " "	9-2-34	7:45 A.M.	Oakland Harbor
26	"	12:40 P.M.	" " "	9-3-34	3:00 P.M.	Judson Pac.-Oakland
27	"	12:50 P.M.	" " "	9-5-34	9:00 A.M.	Std Oil Dock-Rich'd
28	"	1:00 P.M.	" " "			
29	"	1:10 P.M.	" " "			
30	"	1:20 P.M.	" " "	9-3-34	12:45 P.M.	S.C. Co. Whorf, Stege
31	"	1:30 P.M.	" " "			
32	"	1:45 P.M.	" " "	9-3-34	3:00 P.M.	San Pablo Strait
33	"	1:50 P.M.	" " "	10-22-34	4:00 P.M.	Alameda Estuary
34	"	2:00 P.M.	" " "	9-2-34	11:45 A.M.	Point Tiburon
35						
36	9-1-34	10:55 A.M.	Mile Rock Outfall	9-1-34	3:10 P.M.	Land's End Beach
37						
38	9-1-34	11:35 A.M.	Mile Rock Outfall	9-1-34	2:05 P.M.	China Beach
39						
40						
41						
42	9-1-34	12:55 P.M.	Mile Rock Outfall	9-2-34	2:30 P.M.	Ocean Beach
43	"	1:15 P.M.	" " "	9-2-34	9:00 A.M.	Olympic Pier
44						
45	9-1-34	1:55 P.M.	Mile Rock Outfall	9-2-34	10:45 A.M.	Land's End Beach
46						
47						
48	9-7-34	11:00 A.M.	1000' off Bakers Beach	9-7-34	4:10 P.M.	Lower Ocean Beach
49	"	11:20 A.M.	" " " "	9-7-34	3:40 P.M.	Beach at Sloat Blvd.
50	9-5-34	11:05 A.M.	1000' N of Pier No. 37			
51	"	11:15 A.M.	" " " " "	9-7-34	12:15 P.M.	S.E. Angel Island
52	"	11:25 A.M.	" " " " "	9-6-34	9:57 A.M.	Yerba Buena Island
53	"	11:35 A.M.	" " " " "			
54	"	11:45 A.M.	" " " " "	9-12-34	2:45 P.M.	Richmond Harbor
55	"	11:55 A.M.	" " " " "	9-6-34	3:30 P.M.	Alcatraz Island
56	"	12:05 P.M.	" " " " "			
57	"	12:15 P.M.	" " " " "	9-9-34	2:00 P.M.	Castro Pt.-Richmond
58	"	12:25 P.M.	" " " " "			
59	"	12:35 P.M.	" " " " "	9-7-34	11:00 A.M.	Beach at Sloat Blvd
60	"	12:45 P.M.	" " " " "	9-8-34	7:30 A.M.	1/4 Mile off Sausalito
61	"	12:55 P.M.	" " " " "			
62	"	1:55 P.M.	" " " " "			
63	"	2:39 P.M.	" " " " "	9-6-34	9:22 A.M.	Raccoon Strait
64	9-7-34	12 Noon	" " " " "	9-8-34	12:30 P.M.	Oakland Mole
65	9-6-34	10:20 A.M.	1000' N of Lyon St. Beach	9-10-34	1:55 P.M.	Carquinez Strait
66	"	10:40 A.M.	" " " " "			
67	"	11:00 A.M.	" " " " "			

RELEASED				PICKED UP		
No.	Date	Time	Location	Date	Time	Location
68	9-6-34	11:20 A.M.	1000' N of Lyon St. Beach	9-10-34	11:30 A.M.	Point San Pablo
69	"	11:40 A.M.	" " " "	9-7-34	12:10 P.M.	Raccoon Strait
70	9-6-34	12 Noon				
71	9-6-34	12 Noon	1000' N Lyon St. Beach	9-7-34	4:45 P.M.	Rodeo Beach
72	"	12:20 P.M.	" " " " "	9-7-34	10:00 A.M.	Ocean Beach
73	"	12:40 P.M.	" " " " "			
74	"	1:00 P.M.	" " " " "	9-9-34	10:30 A.M.	Emeryville Beach
75						
76	9-7-34	12 Noon	1000' off Bakers Beach	9-7-34	5:35 P.M.	Beach nr. Cliff House
77	"	1:40 P.M.	" " " "	9-7-34	3:10 P.M.	Baker's Beach
78	9-6-34	1:20 P.M.	1000' N. Lyon St. Beach	9-7-34	2:45 P.M.	Baker's Beach
79	"	1:40 P.M.	" " " " "			
80	"	2:00 P.M.	" " " " "	9-27-34	12 Noon	Key Route Fill
81	"	2:20 P.M.	" " " " "	9-10-34	1:00 P.M.	Drakes Bay
82	"	2:40 P.M.	" " " " "	9-12-34	2:30 P.M.	Blunt Pt.-Angel Is.
83						
84	9-7-34	1:00 P.M.	1000' off Bakers Beach	9-7-34	3:25 P.M.	Baker's Beach
85	"	1:20 P.M.	" " " "	9-7-34	3:10 P.M.	Baker's Beach
86						
87	9-6-34	3:00 P.M.	1000' N Lyon St. Beach			
88	"	3:20 P.M.	" " " " "	9-6-34	4:05 P.M.	600' off Lyon St.
89	"	3:40 P.M.	" " " " "			
90	9-7-34	1:40 P.M.	1000' off Bakers Beach	9-7-34	3:15 P.M.	Baker's Beach
91	"	2:00 P.M.	" " " "			
92	"	2:40 P.M.	" " " "	9-9-34	5:00 P.M.	Baker's Beach
93	"	3:00 P.M.	" " " "	9-7-34	5:09 P.M.	Baker's Beach
94	"	3:20 P.M.	" " " "	9-11-34	10:30 A.M.	Baker's Beach
95	"	3:40 P.M.	" " " "	9-8-34	3:00 P.M.	Raccoon Strait
96			No Record	9-16-34	10:00 A.M.	Drakes Bay
97			No Record	9-16-34	8:23 A.M.	Fort Funston
98	9-15-34	9:00 A.M.	500' off Lyon St. Beach			
99	"	9:20 A.M.	" " " " "	9-18-34	7:30 A.M.	Berkeley Beach
100	"	9:40 A.M.	" " " " "	9-15-34	11:00 A.M.	Aquatic Park Pier
101	"	10 A.M.	" " " " "	9-15-34	12 Noon	Aquatic Park Pier
102	9-14-34	9:20 A.M.	1000' off Mile Rock	9-19-34	1:45 P.M.	Emeryville Beach
103	9-15-34	10:20 A.M.	500' N of Lyon St.			
104	9-14-34	10:00 A.M.	Mile Rock Outfall	9-16-34	7:00 A.M.	Beach at Pacheco St.
105	"	10:00 A.M.	" " "	9-15-34	4:30 P.M.	Ocean Beach
106	"	10:00 A.M.	" " "	9-14-34	3:30 P.M.	Nr. Mile Rock Outfall
107						
108						
109	9-14-34	10:00 A.M.	Mile Rock Outfall	9-15-34	10:00 A.M.	Beach at Noriega St.
110						
111	9-15-34	10:40 A.M.	500' N. of Lyon St.			
112	9-14-34	11:00 A.M.	" " " " "	9-15-34	12:30 P.M.	Aquatic Park Pier
113	9-15-34	11:20 A.M.	" " " " "	9-15-34	12:30 P.M.	200 yds. off Pier No. 39
114	"	11:40 A.M.	" " " " "	9-18-34	7:30 A.M.	Nr. Bay Bridge No. E-8
115	"	12 Noon	" " " " "	9-17-34	2:00 P.M.	Near Pt. Diablo
116	"	12:20 P.M.	" " " " "			
117	"	1:00 P.M.	" " " " "			
118	"	1:20 P.M.	" " " " "			
119	"	1:40 P.M.	" " " " "	9-21-34	2:30 P.M.	Rodeo Lagoon Cove
120	"	2:00 P.M.	" " " " "			
121	"	2:20 P.M.	" " " " "	9-18-34	6:00 A.M.	Beach at Moraga St.
122	"	2:40 P.M.	" " " " "			
123	9-18-34	9:00 A.M.	1,000' N of Lyon St.			
124	"	9:30 A.M.	" " " " "			
125	"	10:00 A.M.	" " " " "	9-20-34	1:52 P.M.	North Baker's Beach
126	"	10:30 A.M.	" " " " "			
127	"	11:00 A.M.	" " " " "	9-20-34	6:30 A.M.	Alameda Mole
128	"	11:30 A.M.	" " " " "			
129	"	12 Noon	" " " " "	9-22-34	10:00 A.M.	Isabel Pt.-El Cerrito
130	"	12:30 P.M.	" " " " "			
131	"	1:00 P.M.	" " " " "			
132	"	1:30 P.M.	" " " " "			
133	"	2:00 P.M.	" " " " "			
134	"	2:30 P.M.	" " " " "	9-21-34	7:30 A.M.	Berkeley Beach

RELEASED				PICKED UP		
No.	Date	Time	Location	Date	Time	Location
135	9-23-34	3:30 P.M.	1,700' off Pier No. 37	9-27-34	11:00 A.M.	Key Route Fill
136	9-20-34	9:10 A.M.	1,500' off Baker's Beach	9-23-34	1:25 P.M.	Oakland Terminal
137	"	9:30 A.M.	500' off Baker's Beach	9-22-34	3:00 P.M.	Richmond-N of Ferry
138	"	10:00 A.M.	1,500' off Baker's Beach	9-21-34	7:30 A.M.	Ocean Beach
139	"	10:30 A.M.	" " " "			
140	"	11:00 A.M.	" " " "	9-20-34	4:30 P.M.	Ocean Beach
141	"	11:30 A.M.	" " " "	9-21-34	6:30 P.M.	Ocean Beach
142	"	12 Noon	" " " "	9-20-34	2:10 P.M.	Baker's Beach
143	"	12:30 P.M.	" " " "			
144	"	1:00 P.M.	" " " "			
145	"	1:30 P.M.	" " " "			
146	"	2:00 P.M.	" " " "			
147	9-19-34	9:45 A.M.	1,000' off Baker's Beach			
148	"	10:00 A.M.	" " " "			
149	"	10:30 A.M.	" " " "	9-19-34	1:10 P.M.	Baker's Beach
150	"	11:00 A.M.	" " " "			
151	"	12 Noon	" " " "			
152	"	12:30 P.M.	" " " "	9-19-34	3:05 P.M.	Fort Point
153	"	1:00 P.M.	" " " "	9-19-34	3:15 P.M.	Fort Point
154	"	1:30 P.M.	" " " "	9-19-34	3:30 P.M.	Fort Point
155	"	2:00 P.M.	" " " "	9-19-34	3:30 P.M.	Fort Point
156	"	2:30 P.M.	" " " "	9-20-34	6:00 A.M.	Fort Point
157	"	3:00 P.M.	" " " "	9-22-34	4:00 P.M.	Tennessee Cove
158	"	3:30 P.M.	" " " "			
159	"	4:00 P.M.	" " " "			
160						
161	8-20-34	2:30 P.M.	1,500' off Baker's Beach			
162						
163	9-20-34	11:00 A.M.	500' off Baker's Beach	9-22-34	2:00 P.M.	Bakers Beach
164	"	3:30 P.M.	1,500' off Baker's Beach			
165	9-21-34	9:36 A.M.	500' off Baker's Beach	9-27-34	12:05 P.M.	West Alameda
166	"	10:30 A.M.	" " " "			
167	"	11:00 A.M.	" " " "	9-24-34	12 Noon	Ocean Beach
168	"	11:30 A.M.	" " " "			
169	"	12 Noon	" " " "			
170	"	1:00 P.M.	" " " "			
171	"	1:30 P.M.	" " " "			
172	"	2:00 P.M.	" " " "			
173	"	2:30 P.M.	" " " "	9-23-34	7:30 A.M.	Alameda Beach
174	"	3:00 P.M.	" " " "			
175	"	3:30 P.M.	" " " "			
176	9-22-34	10:00 A.M.	" " " "			
177	"	10:30 A.M.	1,500' off Lyon St.	9-25-34	6:25 A.M.	Baker's Beach
178	"	11:00 A.M.	" " " "	9-26-34	9:30 A.M.	Point Bonita
179	"	11:30 A.M.	" " " "			
180	"	12 Noon	" " " "	10-1-34	7:00 A.M.	Point San Pedro (S.Mc)
181	"	12:30 P.M.	" " " "			
182	"	1:00 P.M.	" " " "			
183	"	1:30 P.M.	" " " "	9-24-34	2:20 P.M.	Baker's Beach
184	"	2:30 P.M.	" " " "	9-25-34	2:45 P.M.	Berkeley Beach
185	"	3:00 P.M.	" " " "	9-30-34	3:20 P.M.	Salado Beach
186	"	3:30 P.M.	" " " "	9-22-34	4:15 P.M.	Crissey Field Beach
187	"	4:30 P.M.	" " " "	9-24-34	7:15 A.M.	Ft. Powell St. Oakland
188	"	6:00 P.M.	" " " "			
189	9-23-34	11:30 A.M.	1,700' off Pier No. 37			
190	"	12 Noon	" " " "	10-1-34	10:00 A.M.	Ingelside-Oc. Beach
191	"	12:30 A.M.	" " " "	10-20-34	3:10 P.M.	San Lorenzo Beach
192	"	1:00 P.M.	" " " "			
193	"	1:30 P.M.	" " " "			
194	"	2:00 P.M.	" " " "			
195	"	2:30 P.M.	" " " "			
196	"	3:00 P.M.	" " " "			
197	9-25-34	6:15 A.M.	1,000' off Mile Rock			
198	"	6:45 A.M.	" " " "	10-3-34	6:30 A.M.	3 Miles So. H.M. Bay
199	"	7:15 A.M.	" " " "	9-29-34	4:50 P.M.	Berkeley Beach
200	"	7:45 A.M.	" " " "	9-26-34	9:00 A.M.	Ocean Beach
201	"	8:15 A.M.	" " " "	9-25-34	3:00 P.M.	Lands End Beach

RELEASED				PICKED UP		
No.	Date	Time	Location	Date	Time	Location
202	9-25-34	8:45 A.M.	1,000' off Mile Rock	9-26-34	3:30 P.M.	Bakers Beach
203	"	9:45 A.M.	" " " "			
204	"	10:15 A.M.	" " " "	10-4-34	11:00 A.M.	Muir Beach (Marin Co.)
205	"	10:45 A.M.	" " " "			
206	"	11:15 A.M.	" " " "	9-29-34	2:45 P.M.	Lands End
207	"	11:45 A.M.	" " " "	10-1-34	1:30 P.M.	Salado Beach
208	"	12:30 P.M.	" " " "			
209	"	1:15 P.M.	" " " "	10-1-34	3:15 P.M.	Salado Beach
210	9-26-34	8:30 P.M.	1,000' off Lyon St.			
211	"	9:00 A.M.	" " " "	10-3-34	9:30 A.M.	Rockaway Beach
212	"	9:30 A.M.	" " " "	9-27-34	2:12 P.M.	Off Transportation Dk.
213	"	10:10 A.M.	" " " "	9-27-34	8:30 A.M.	Aquatic Park Pier
214	"	10:30 A.M.	" " " "	9-26-34	1:25 P.M.	Transportation Dock
215	"	8:00 A.M.	" " " "			
216	"	11:30 A.M.	" " " "	10-5-34	6:00 P.M.	San Gregorio Beach
217	"	12 Noon	" " " "			
218	"	1:30 P.M.	" " " "			
219	"	2:00 P.M.	" " " "	10-21-34	4:00 P.M.	Sandspit nr. Bolinas
220	"	2:30 P.M.	" " " "			
221	"	3:00 P.M.	" " " "			
222	9-27-34	6:30 A.M.	Baker's Beach	10-5-34	10:00 P.M.	Fleming Pt.-Albany
223	"	7:00 A.M.	" "			
224	"	7:30 A.M.	"			
225	"	8:00 A.M.	500' off Baker's Beach	10-23-34	6:00 A.M.	Salado Beach
226	"	8:30 A.M.	" " "	10-1-34	9:00 A.M.	Near Mussel Rock
BOTTLE FLOAT NUMBERS 226 TO 262 INCLUSIVE, WERE NOT RELEASED.						
263	9-27-34	9:00 A.M.	500' off Baker's Beach			
264	"	10:00 A.M.	" " " "	10-1-34	9:00 A.M.	So. Fleishhacker Pool
265	"	10:30 A.M.	" " " "			
266	"	11:45 A.M.	" " " "			
267	"	12:15 P.M.	" " " "			
268	"	12:45 P.M.	" " " "	10-1-34	2:30 P.M.	Muir Beach (M. Co.)
269	"	1:15 P.M.	" " " "	10-2-34	2:00 P.M.	4 Miles So. Fl'kr Pool
270	"	1:45 P.M.	" " " "			
271	9-28-34	7:00 A.M.	1,000' off Baker's Beach	10-2-34	1:00 P.M.	Salado Beach
272	"	7:30 A.M.	" " " "	9-29-34	1:20 P.M.	Yerba Buena Island
273	"	8:00 A.M.	" " " "	10-2-34	1:00 P.M.	Berkeley Beach
274	"	8:30 A.M.	" " " "	10-1-34	8:30 A.M.	Oakland Outer Harb.
275						
276						
277	9-28-34	10:30 A.M.	1,000' off Baker's Beach	10-1-34	9:00 A.M.	Ocean Beach
278						
279						
280						
281	9-28-34	1:00 P.M.	1,000' off Baker's Beach	10-1-34	10:30 A.M.	Cliff House Beach
282	"	1:30 P.M.	" " " "	10-3-34	9:45 A.M.	Isabel Pt.-Albany
283						
284	9-28-34	3:00 P.M.	1,000' off Baker's Beach	10-1-34	9:00 A.M.	Mussel Rock Beach
285			No Record	10-21-34	11:15 A.M.	Rodeo Lagoon

CITY AND COUNTY OF SAN FRANCISCO
DEPARTMENT OF PUBLIC WORKS
BOARD OF CONSULTING SANITARY ENGINEERS
H. P. EDDY, Chairman. J. G. HYDE, Secretary.
L. B. REYNOLDS C. C. KENNEDY

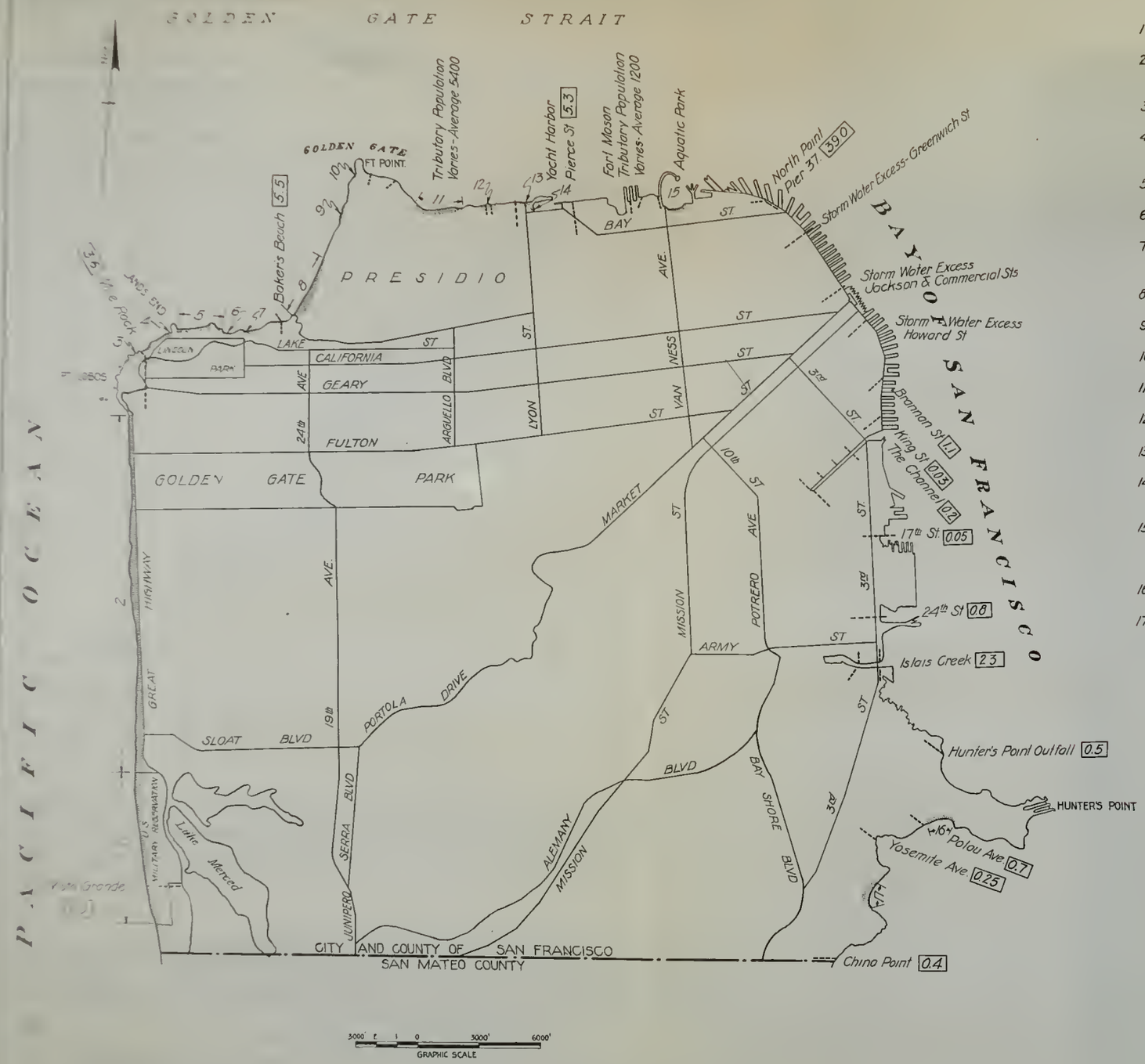
BOTTLE FLOAT TRAVEL.

DRAWN BY A.W.L. TRACED BY A.W.L. CHECKED BY B.B. SCALE: NO. ... OF SHEETS DATE Dec. 5 1934 FILE A-10.991

PLATE 31


SAN FRANCISCO BAY
PACIFIC OCEAN
BERKELEY
EMERYVILLE
OAKLAND
ALAMEDA
RICHMOND
POINT RICHMOND
ANGEL IS
SAUSALITO
RICHARDSON BAY
YERBA BUENA IS
ALCATRAZ IS
PIER 37
NORTH PT
VAN NESS
LYON ST
MISSION
MARKET
ST
AVE
PRESIDIO
MILITARY RESERVATION
BAKER'S BEACH
CALIFORNIA
FULTON
GOLDEN GATE
PARK
WAY
LINCOLN
19th AVE.
25th AVE.
JUNIPERO SERRA BLVD
SLOAT BLVD
GREAT HIGHWAY
LAND'S END
MILE ROCK
PT LOBOS
PT BONITA
PT DIABLO
FORT PT
GOLDEN GATE
STRAIT
RACCOON STRAIT
SAN FRANCISCO CITY AND COUNTY
SAN MATEO COUNTY
MERCED LAKE
LEGEND
● = Baker's Beach
■ = Pier 37
▲ = Lyon St.
♦ = Mile Rock
Symbols denote station from which bottle floats were released
NOTES
Numbers refer to records on Table 9.
+ indicates Flood Tide at time of release
− indicates Ebb Tide at time of release.
SCALE IN MILES
Map 1
CITY AND COUNTY OF SAN FRANCISCO
DEPARTMENT OF PUBLIC WORKS
BOARD OF CONSULTING SANITARY ENGINEERS
M. P. EDDY, Chairman.
L. B. REYNOLDS
C. G. HYDE, Secretary.
C. C. KENNEDY
BOTTLE FLOAT TRAVEL.
DRAWN BY
TRACED BY
CHECKED BY
SCALE:
NO. ..... OF ..... SHEETS
DATE Dec 1 1934
FILE A-10.997

PLATE 32.



BEACH DATA

1. Beach, U S Military Reserve, public use restricted
2. Beach along Great Highway used for bathing, fishing and other recreational purposes by great numbers of persons
3. Several small beaches, inaccessible at high tide
4. Land's End Beach, 50'x 500', easily reached by several trails, in process of development by the Park Commission
5. Numerous sandy coves, inaccessible
6. Dead Man's Cove, 30'x 200', not easily reached
7. China Beach, 20'x 350', to be developed by the Recreation Commission and State Park Commission for swimming and fishing. A clubhouse is to be constructed
8. Baker's Beach, 60'x 3,000', at present used mainly for surf fishing
9. Beach, 30'x 500', access difficult
10. Beach, 15'x 300', access difficult
11. Beach 20'x 2,000', opposite Crissy Field, public use prohibited
12. Beach, 20'x 500', opposite Crissy Field, public use prohibited
13. Beach, 20'x 350' (200' in Presidio; public use prohibited)
14. Marina Yacht Harbor, contains breakwater, clubhouse and beach, 20'x 150'. The harbor shelters pleasure boats exclusively
15. Aquatic Park; circular concrete pleasure pier, beach 60'x 600', boat house and small pleasure craft. Proposed development by Park Commission includes beach, 150 x 600, bathhouse, Spanish type clubhouses and water sports for school children
16. Beach, 30'x 1,200', not readily accessible.
17. Gilman Playground; to be developed as an athletic field and for other recreational uses

LEGEND

5.0 Denotes outfall discharging sewage and the estimated average daily volume (1934) in millions of gallons.

Map 2

CITY AND COUNTY OF SAN FRANCISCO
DEPARTMENT OF PUBLIC WORKS
BOARD OF CONSULTING SANITARY ENGINEERS
M. P. EDDY, Chairman. C. G. HYDE, Secretary
L. S. REYNOLDS C. C. KENNEDY

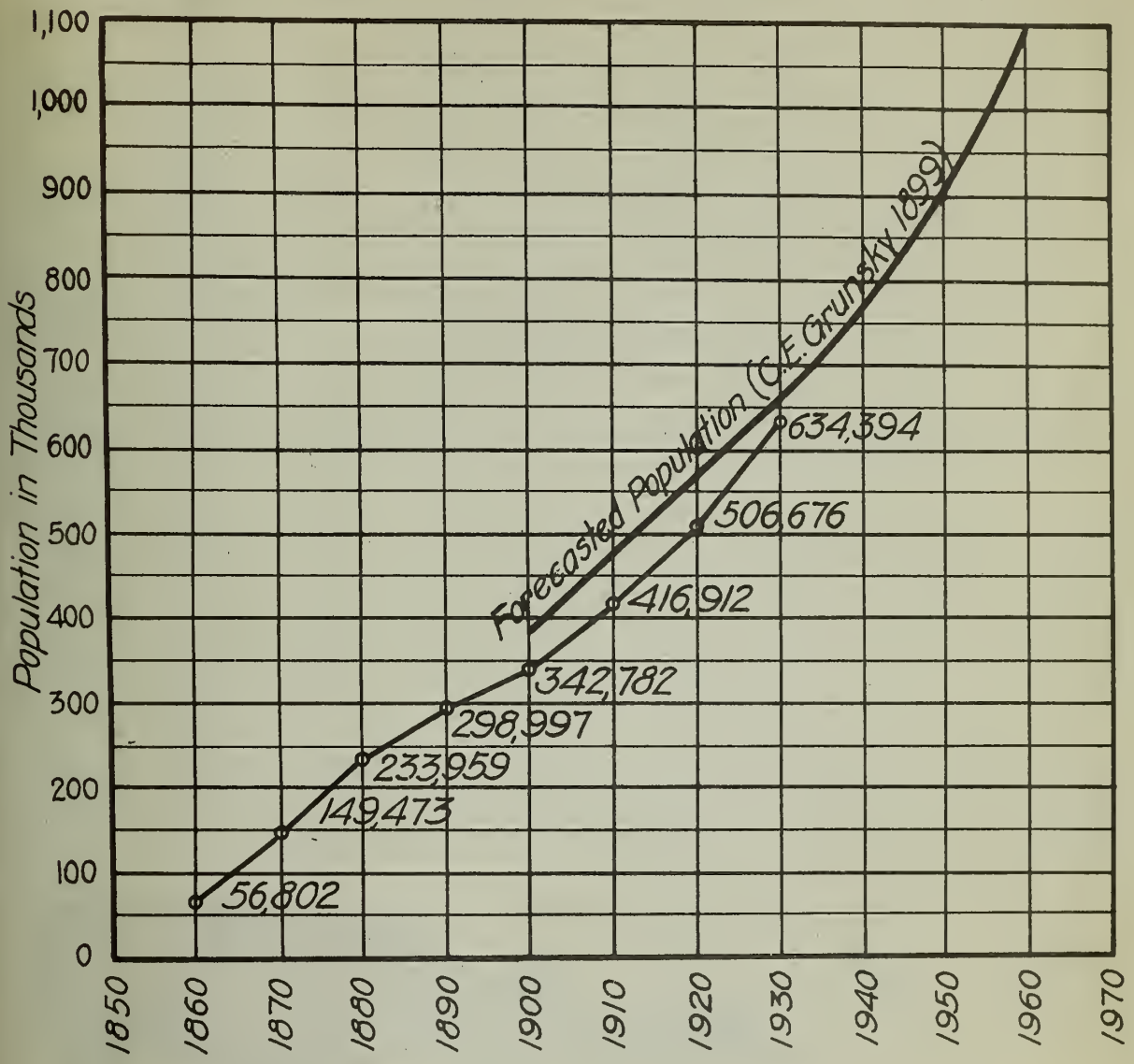
RECREATIONAL BEACHES, SEWAGE QUANTITIES AND LOCATION OF SEWAGE AND STORM SEWAGE DISCHARGES.

DRAWN BY RWU TRACED BY RWU CHECKED BY	SCALE: NO. ..... OF .... SHEETS	DATE Nov 2 1935	FILE A-10,993

PLATE 33

Diagram 16

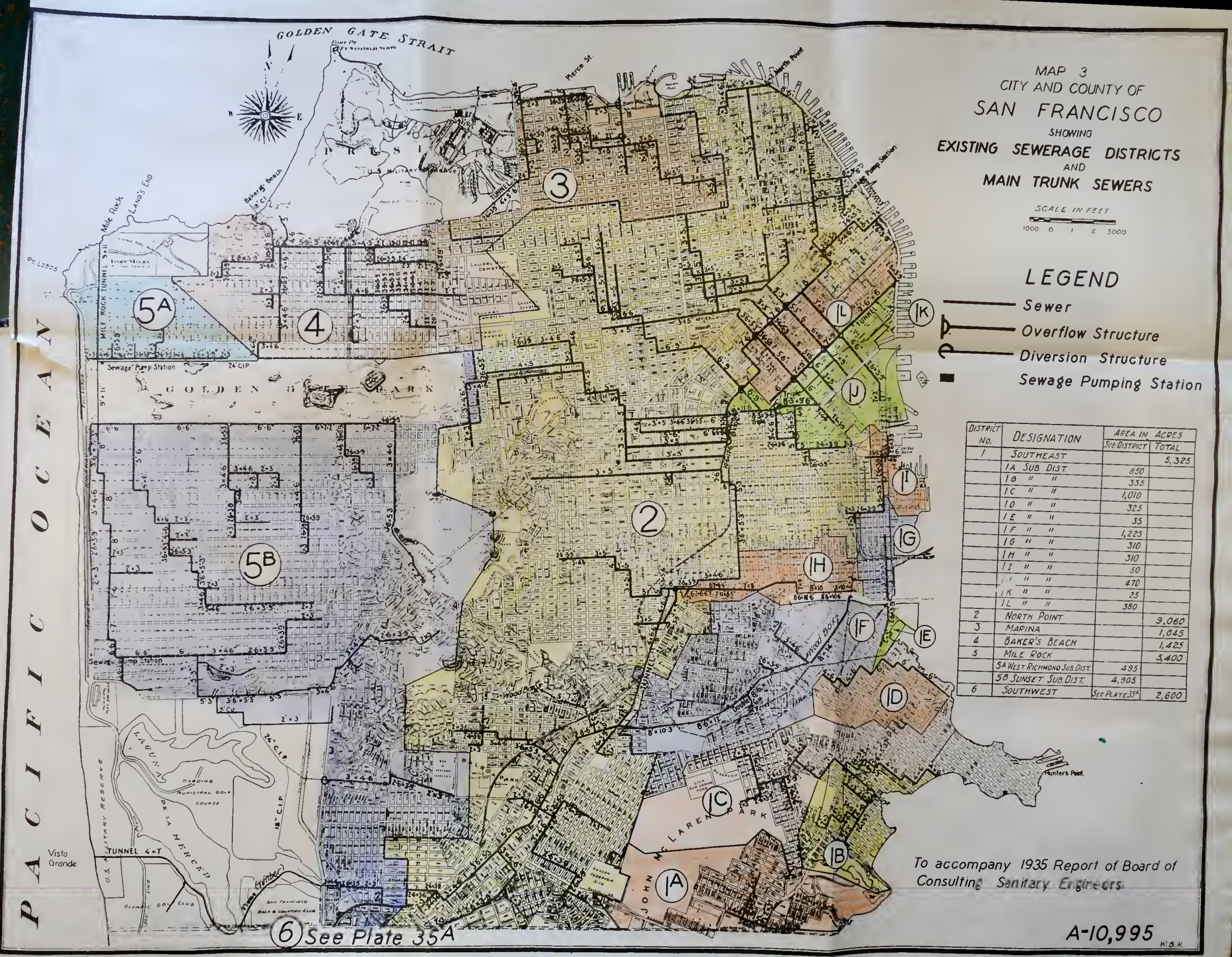
POPULATION OF SAN FRANCISCO - CALIFORNIA



Note: The curve of forecasted population, 1900 to 1960, is based upon figures presented in a "Report Upon A System of Sewerage For The City And County of San Francisco," by C.E. Grunsky, 1899, page 21.

CITY AND COUNTY OF SAN FRANCISCO DEPT. OF PUBLIC WORKS - BOARD OF CONSULTING SANITARY ENGINEERS			
POPULATION SAN FRANCISCO.			
DRAWN BY R.W.J. TRACED BY R.W.J. CHECKED BY B.B.	SCALE: NO. .... OF .... SHEETS	DATE May 6, 1935	FILE L-10,994

PLATE 34.



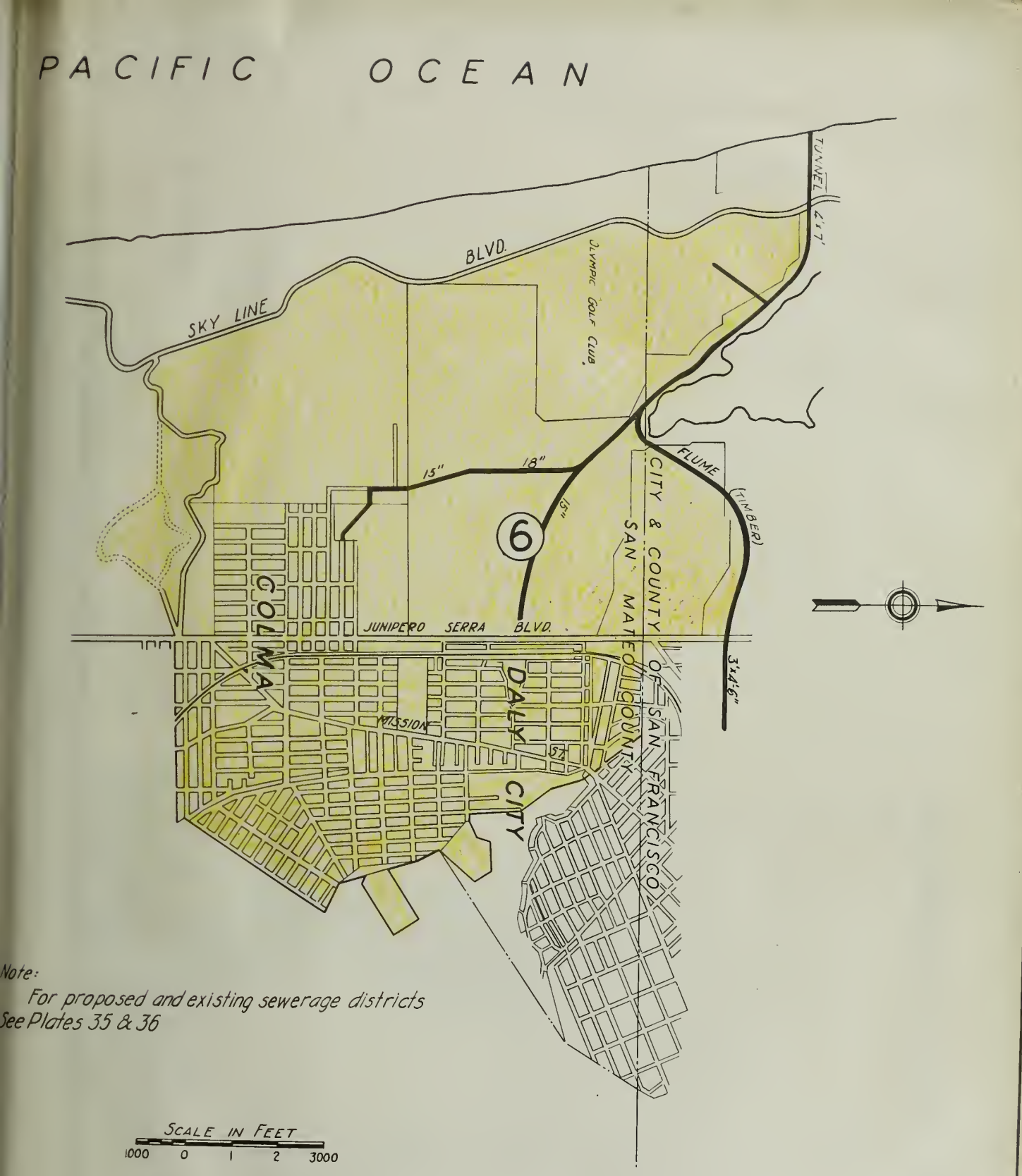
District No.	Designation	Area in Acres: Sub-District	Area in Acres: Total
1	Southeast		5,325
	1A Sub. Dist.	850	
	1B " "	335	
	1C " "	1,010	
	1D " "	325	
	1E " "	35	
	1F " "	1,225	
	1G " "	310	
	1H " "	310	
	1I " "	50	
	1J " "	470	
	1K " "	25	
	1L " "	380	
2	North Point		9,060
3	Marina		1,045
4	Baker's Beach		1,425
5	Mile Rock		5,400
	5A West Richmond Sub. Dist.	495	
	5B Sunset Sub. Dist.	4,905	
6	Southwest	See Plate 35A	2,600

To accompany 1935 Report of Board of Consulting Sanitary Engineers.

A-10,995

W.B.H.

PLATE 35.

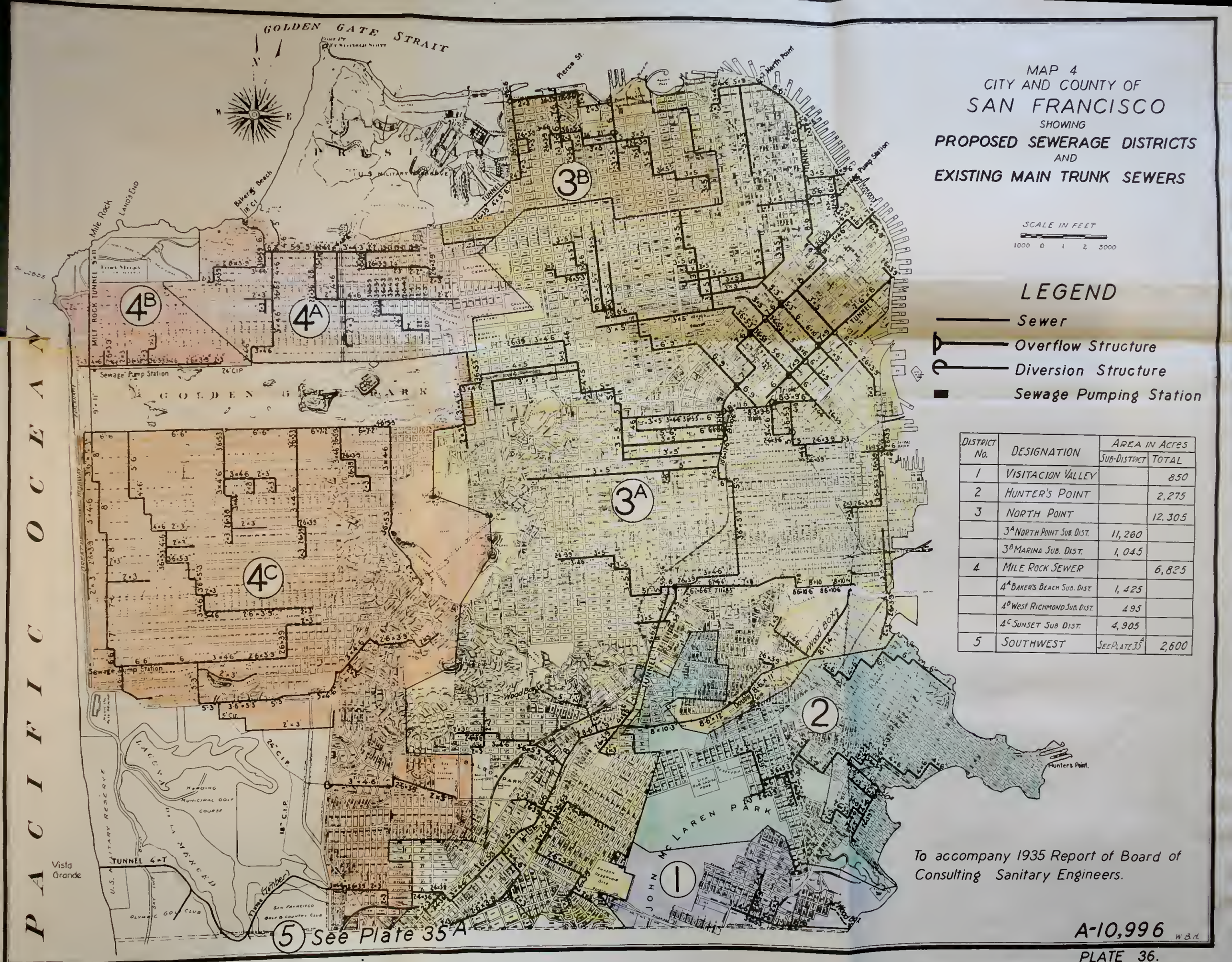


CITY AND COUNTY OF SAN FRANCISCO
DEPT. OF PUBLIC WORKS - BOARD OF CONSULTING SANITARY ENGINEERS

MAP SHOWING
EXISTING SOUTHWEST SEWERAGE DISTRICT.

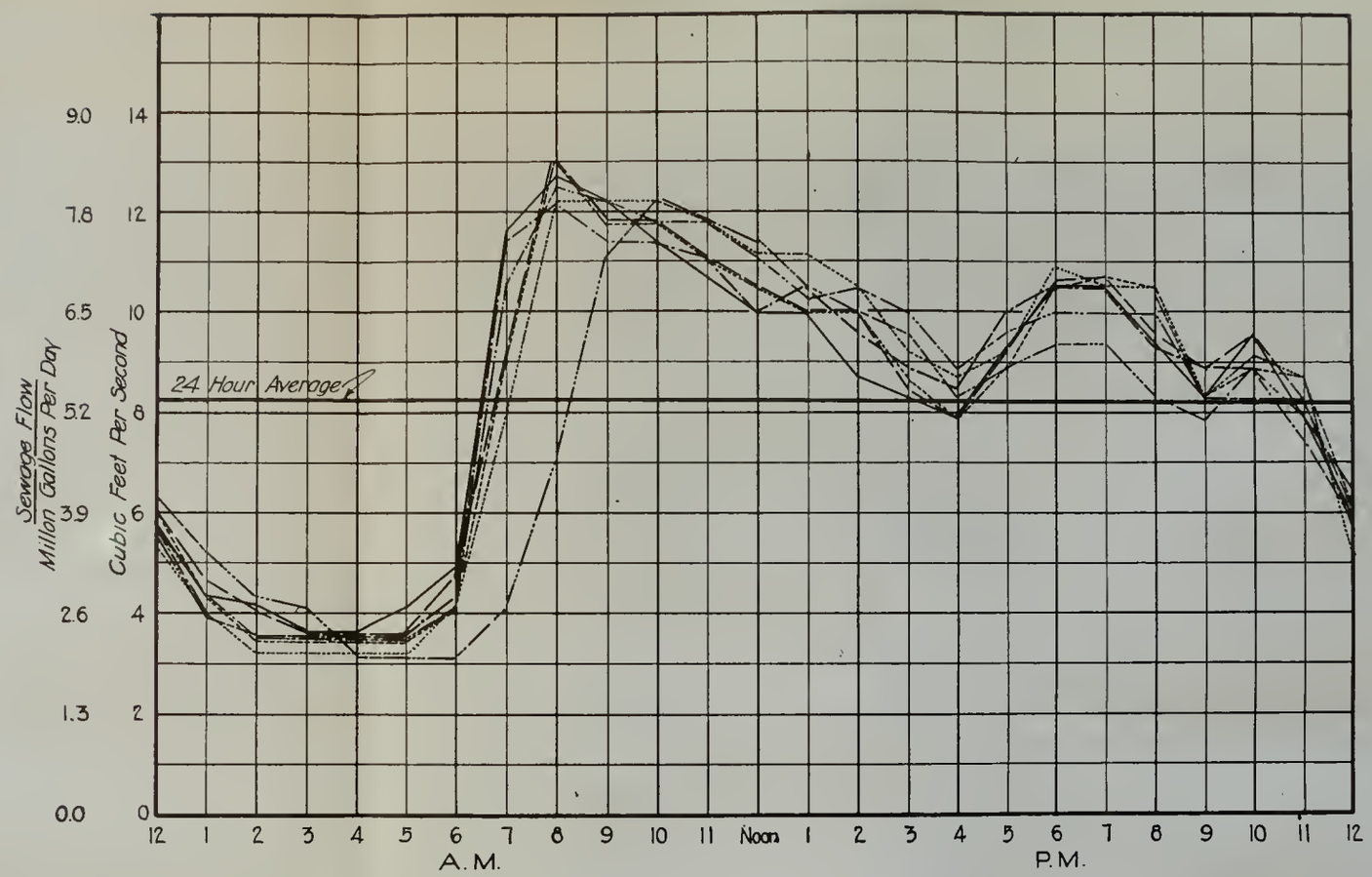
DRAWN BY W.B.H. TRACED BY W.B.H. CHECKED BY B.B.	SCALE: AS SHOWN NO. .... OF .... SHEETS	DATE APRIL 1935	FILE L-11,013

PLATE 35A



District No.	Designation	Area in Acres	
		Sub-District	Total
1	Visitacion Valley		850
2	Hunter's Point		2,275
3	North Point		12,305
	3A North Point Sub. Dist.	11,260	
	3B Marina Sub. Dist.	1,045	
4	Mile Rock Sewer		6,825
	4A Baker's Beach Sub. Dist.	1,425	
	4B West Richmond Sub. Dist.	495	
	4C Sunset Sub Dist.	4,905	
5	Southwest	See Plate 35A	2,600

Diagram 17



FLOW DATA						
Legend	Day	Total	Min. Rate		Max. Rate	
		M.G.	M.G.D.	C.F.S.	M.G.D.	C.F.S.
————	Monday	5.4	2.1	3.2	7.9	12.2
- - - - -	Tuesday	5.4	2.2	3.4	8.4	13.0
— — — —	Wednesday	5.4	2.3	3.6	8.4	13.0
————	Thursday	5.4	2.3	3.6	8.1	12.6
—·—·—	Friday	5.4	2.3	3.5	7.9	12.2
————	Saturday	5.5	2.3	3.5	8.1	12.5
—··—··—	Sunday	5.0	2.0	3.1	7.9	12.2
	Average	5.3	2.2	3.4	8.1	12.5

Notes: Flows determined by weir (recording gage) located in manhole at Pierce and Alhambra Sts.
Area tributary to weir 60% of district, 100% assumed at some average rate.

CITY AND COUNTY OF SAN FRANCISCO
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FLOW MEASUREMENTS

MARINA SUB-DISTRICT.

DRAWN BY R.W.J. TRACED BY R.W.J. CHECKED BY	SCALE: NO. ..... OF ..... SHEETS	DATE 4-7-1935	FILE A-10,997

PLATE 37.

Diagram 18

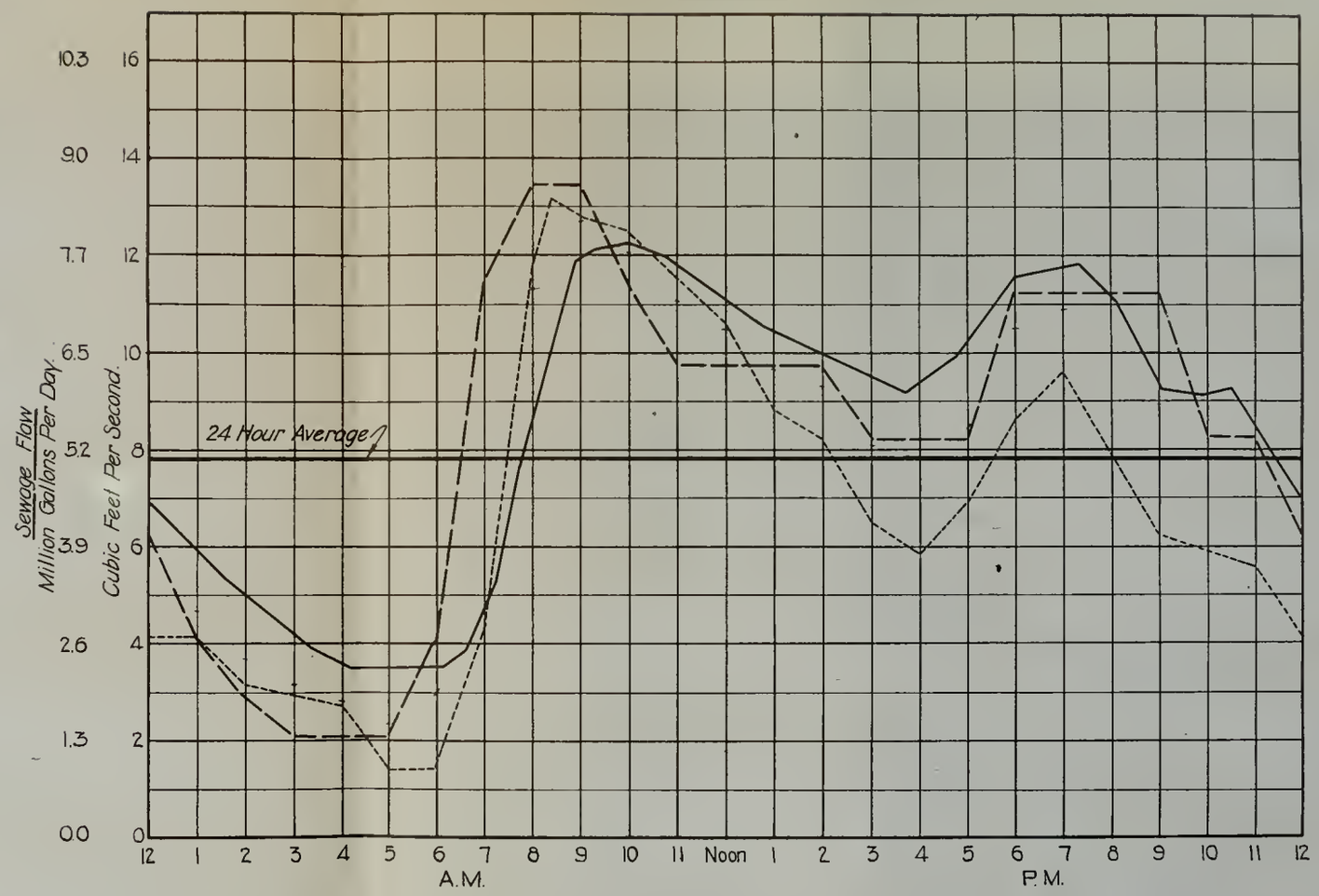

Table 15

FLOW DATA						
Legend	Date	Total	Min. Rate		Max. Rate	
		M.G.	M.G.D.	C.F.S.	M.G.D.	C.F.S.
----------	Oct. 3 & 4, 1932	4.4	.9	1.4	8.4	13.2
— — — — —	June, 29 & 30, 1933	5.3	1.4	2.1	8.6	13.5
————	Dec. 6 & 7, 1934	5.5	3.5	3.5	7.9	12.2

Notes: Flows for Oct. 3rd and 4th, 1932 and June 29th and 30th 1933 determined at manhole on Seacliff Ave. between Twenty-Fifth Ave. and Twenty-Sixth Ave. by measuring depth of flow and computing quantities from hydraulic properties.

Flows for Dec. 6th and 7th 1934 determined by measuring depth of flow at tributary trunk lines. Addition made for flow in lower area not tributary to Twenty-Fourth Ave. and Lake St.

CITY AND COUNTY OF SAN FRANCISCO
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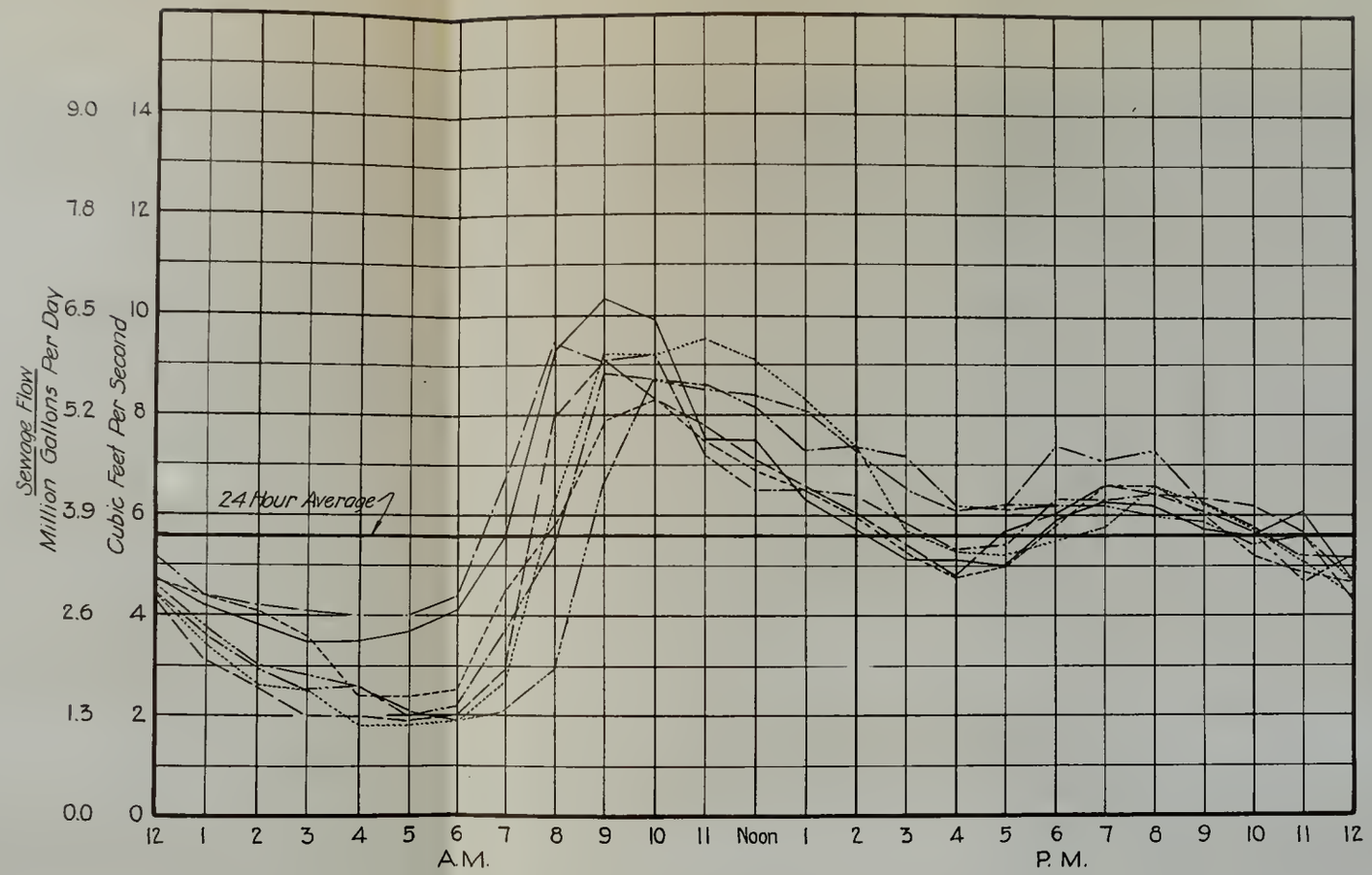
FLOW MEASUREMENTS

BAKER'S BEACH SUB-DISTRICT.

DRAWN BY R.W.J. TRACED BY R.W.J. CHECKED BY B.B.	SCALE: NO. ..... OF .... SHEETS	DATE May. 6. 1935.	FILE A-10.998

PLATE 38.

Diagram 19



FLOW DATA						
Legend	Day	Total	Min. Rate		Max. Rate	
		M.G	M.G.D.	C.F.S.	M.G.D	C.F.S.
.....	Monday	3.5	1.2	1.8	6.1	9.5
- - - - - -	Tuesday	3.4	1.6	2.5	5.4	8.4
— — — —	Wednesday	3.4	1.2	1.9	6.0	9.2
———	Thursday	3.7	2.3	3.5	6.7	10.4
—·—·—	Friday	3.9	2.6	4.0	6.1	9.5
—··—··—	Saturday	3.7	1.3	2.0	5.7	8.8
—···—···—	Sunday	3.5	1.2	1.8	5.6	8.6
	Average	3.6	1.6	2.5	6.0	9.2

Notes: Flows determined by weir (recording gage) located in manhole approximately 100' north of Lincoln Way and 48th Ave.
Area tributary to weir 90% of district, 100% assumed at same average rate.

CITY AND COUNTY OF SAN FRANCISCO
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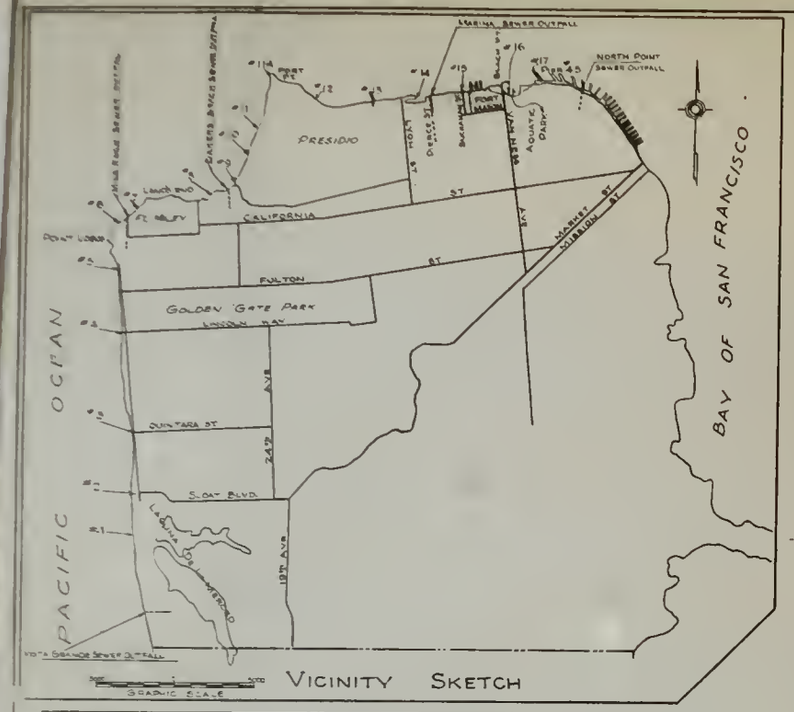
FLOW MEASUREMENTS

SUNSET SUB-DISTRICT.

DRAWN BY R.W.J. TRACED BY R.W.J. CHECKED BY B.B.	SCALE: NO. ..... OF ..... SHEETS	DATE April 1930	FILE A-10,999

PLATE 39.



VICINITY SKETCH

TABLE 11

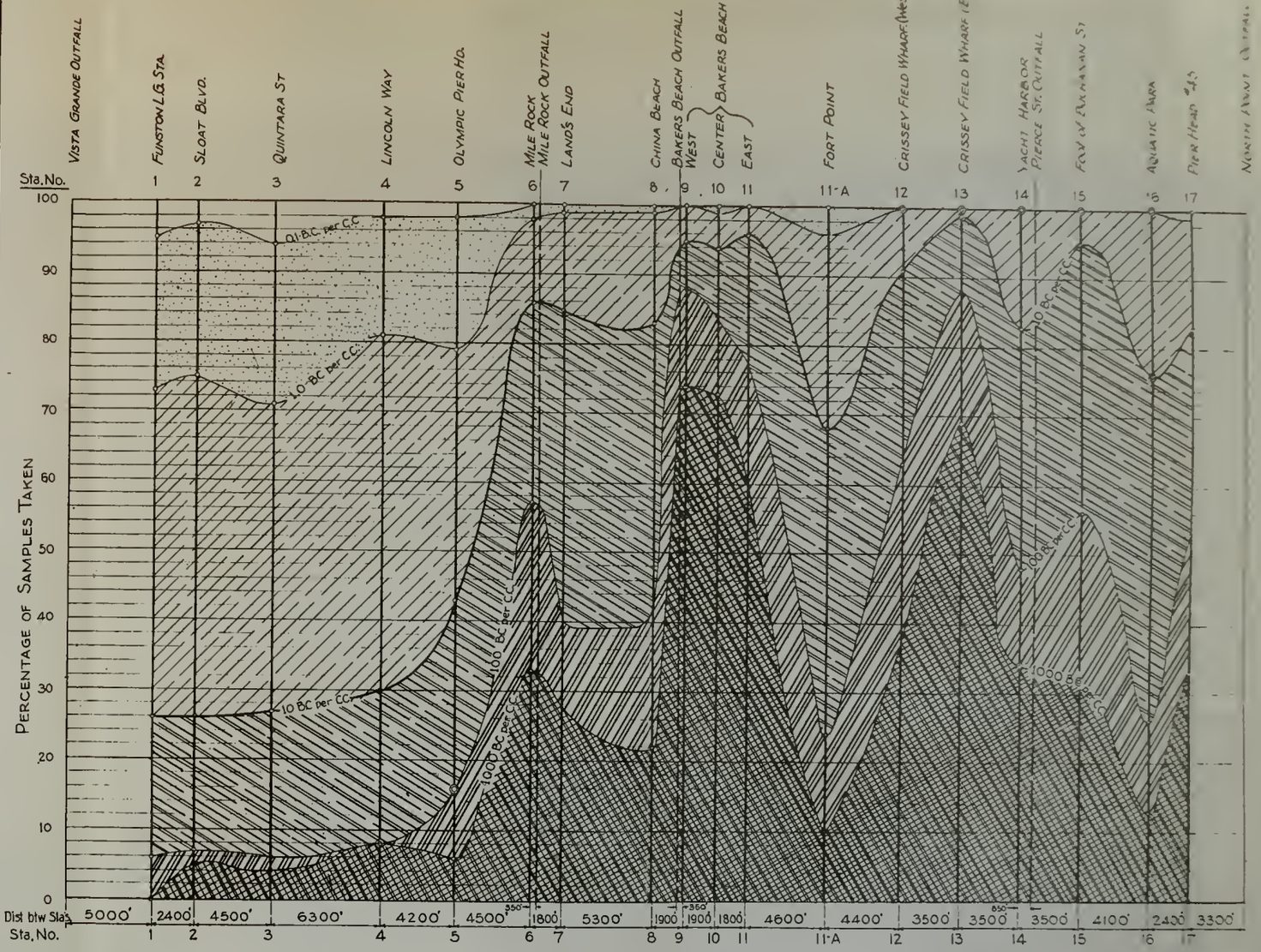
BACTERIAL (Presumptive B. Coli) POLLUTION OF THE NORTH AND WEST SHORES.

Sta No.	Dist Feet btw. Stas.	Percentages of Samples and of Time when the nos. of B-Coli per C.C. were as great or greater than the values indicated below. 0.1	1.0	10	100	1000	Avg's.*	Percentages of samples representing stated tidal conditions. Flood	Ebb	Slack	Estimated No. of B-Coli per C.C. Avg. for Period. Min.**	Max.**
1		95	73	26	6	0	40	44	54	2	8	50
	2400											
2		97	75	26	7	5	42	47	53	0	54	300
	4500											
3		94	71	27	6	4	40	47	53	0	45	240
	6300											
4		98	81	30	8	8	45	43	51	6	83	460
	4200											
5		98	79	43	16	6	48	43	55	2	73	400
	4500											
6		100	98	86	57	33	75	42	56	2	357	1960
	1800											
7		100	99	85	41	28	71	42	56	2	297	1640
	5300											
8		100	99	83	42	22	69	42	52	6	244	1340
	1900											
9		100	100	95	88	74	91	46	54	0	755	4150
	1900											
10		100	99	94	84	73	90	46	54	0	742	4080
	1800											
11		100	100	96	77	59	86	46	54	0	610	3350
	4600											
11-A		100	96	68	24	10	60	46	54	0	119	650
	4400											
12		100	100	91	63	37	78	44	54	2	399	2190
	3500											
13		100	100	99	88	69	91	40	54	6	710	3900
	3500											
14		100	100	83	48	34	73	42	56	2	358	1970
	3500											
15		100	100	95	56	32	77	40	52	8	348	1910
	4100											
16		100	100	76	26	13	63	44	56	0	148	820
	2400											
17		100	99	83	53	34	74	44	54	2	362	1990
Average all Sta's.		99	93	72	44	30	68	44	54	2	317	1740
Averages Stas. 1-5		96	76	30	9	5	43	-	-	-	57	310
Averages Stas. 6-17		100	99	87	57	40	77	-	-	-	420	2310

* ∞ Positive tubes. ** Estimated as probable average minimum and maximum numbers respectively. Vista Grande outfall to Sta. 1--5000' Sta. 17 to N.Pt. Sewer outfall - 3300'

(NOTE.) Results of 52 sets of samples collected at approximately weekly intervals during the period Feb. 6, 1933 to Feb. 7, 1934 inclusive. Samples collected and analyzed by the Department of Public Health. Two tubes each of 10, 1.0, 0.1, 0.01 and 0.001 cc. of all the samples were incubated.

DIAGRAM 20



NOTE

All samples taken at the shore except Sta. No's 12 · 13 · 14 · & 17.

LEGEND

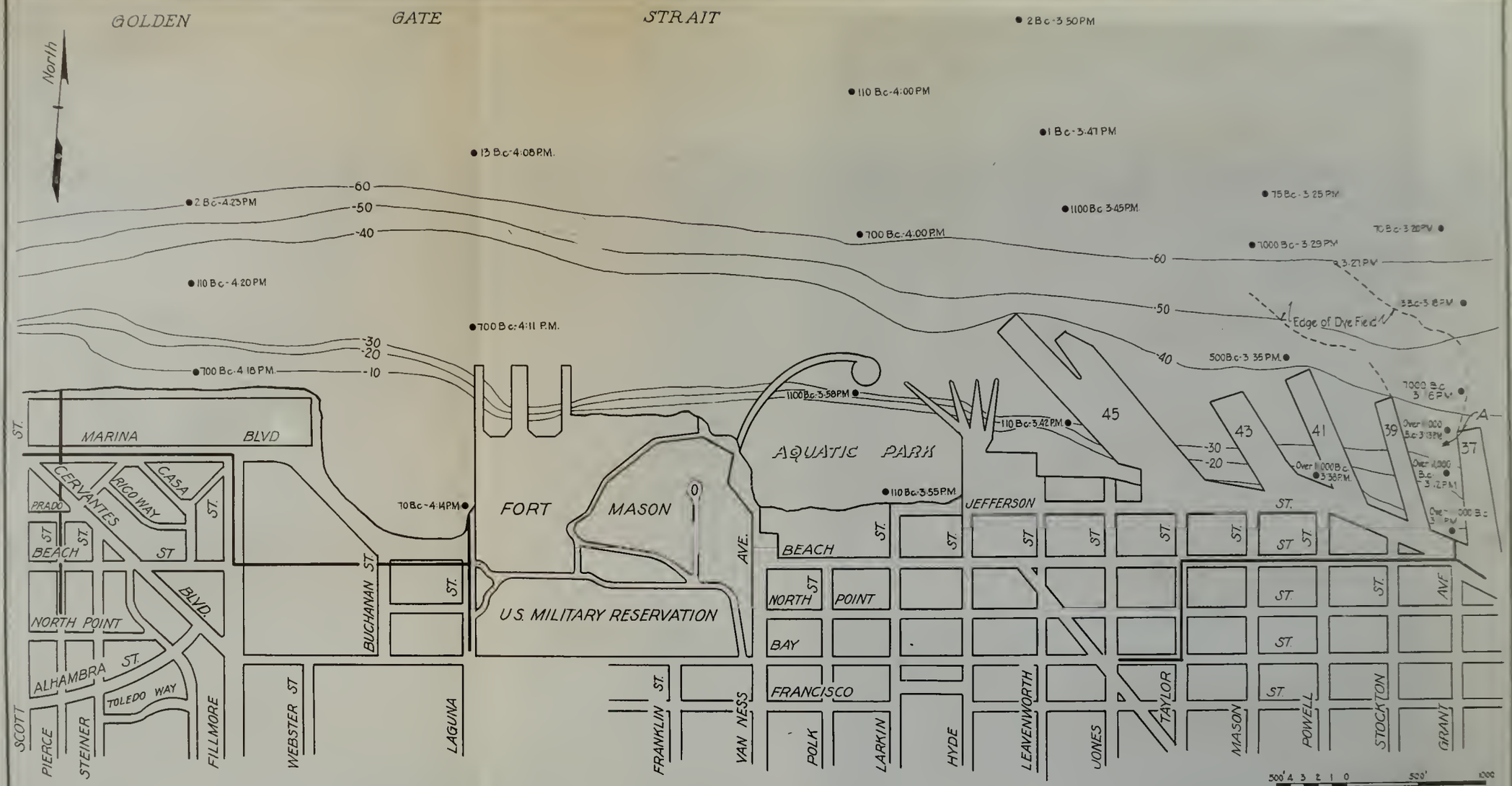
SYMBOL	No. of B. Coli Per C.C.	
	More than	0.1
	Less than	1.0
	More than	1.0
	Less than	10
	More than	10
	Less than	100
	More than	100
	Less than	1000
	More than	1000

CITY AND COUNTY OF SAN FRANCISCO
DEPARTMENT OF PUBLIC WORKS
BOARD OF CONSULTING SANITARY ENGINEERS
H. P. EDDY, Chairman. C. G. HYDE, Secretary.
L. B. REYNOLDS C. C. KENNEDY

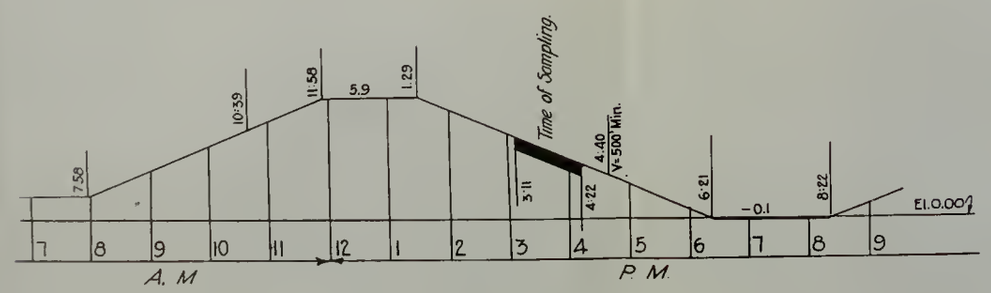
AVERAGE NUMBERS OF B. COLI IN SHORE WATERS
FEBRUARY 6, 1933 - FEBRUARY 7, 1934.

DRAWN BY C.M.M. TRACED BY H.L.M. CHECKED BY J.B.R. SCALE: NO. OF SHEETS DATE FILE A-11,000

PLATE 40



Map 5



TIDE CHART
Sept. 24th, 1934.

~ Notes ~

With dilutions used no count over 11,000 B.c per c.c. was possible.
All samples taken at surface.
"A" indicates point at which dye (Water Red M O) was dropped in water from boat.
Contours indicate depths below mean lower low tide. (11.71 below City Datum.)
B.c. denotes B. coli per c.c.

CITY AND COUNTY OF SAN FRANCISCO
DEPARTMENT OF PUBLIC WORKS
BOARD OF CONSULTING SANITARY ENGINEERS
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L. B. REYNOLDS — C. C. KENNEDY

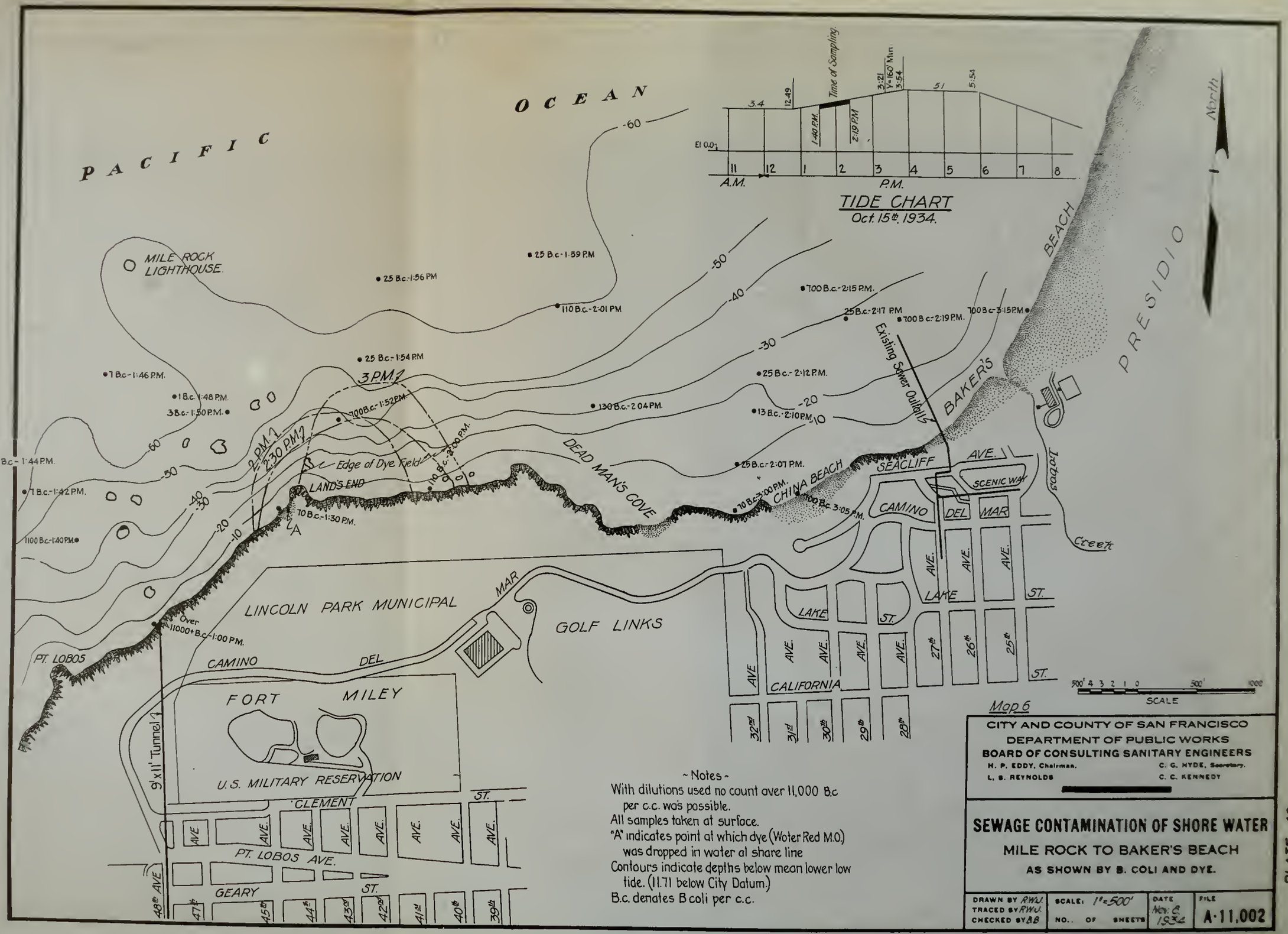
SEWAGE CONTAMINATION OF SHORE WATER

NORTH POINT TO MARINA

AS SHOWN BY B. COLI AND DYE.

DRAWN BY R.W.J. TRACED BY R.W.J. CHECKED BY B.B.	SCALE: NO. ..... OF ..... SHEETS	DATE May 1 1935	FILE A-11,001

PLATE 41.



~ Notes ~

With dilutions used no count over 11,000 B.c per c.c. was possible.

All samples taken at surface.

"A" indicates point at which dye (Water Red M.O.) was dropped in water at shore line

Contours indicate depths below mean lower low tide. (11.71 below City Datum.)

B.c. denotes B coli per c.c.

PLATE 42

TABLE 13.

SUSPENDED SOLIDS P.P.M.						
HOUR	MONDAY OCT. 1.			THURSDAY OCT. 4.		
	TOTAL	FIXED	VOLATIL	TOTAL	FIXED	VOLATIL
8-9 AM	460	105	355	460	95	365
9-10	595	115	480	435	95	340
10-11	630	110	520	425	65	360
11-12	640	175	465	460	60	400
12-1 PM	515	85	430	380	50	330
1-2	455	80	375	270	45	225
2-3	460	70	390	310	45	265
3-4	450	60	390	370	45	325
4-5	400	120	280	340	55	285
5-6	320	50	270	320	110	210
6-7	340	50	290	290	45	245
7-8	355	50	305	470	60	410
8-9	520	70	450	580	70	510
9-10	450	65	385	420	50	370
10-11	345	60	285	340	50	290
11-12	300	55	245	230	35	195
12-1 AM	215	45	170	210	40	170
1-2	120	20	100	135	25	110
2-3	95	15	80	125	25	100
3-4	70	5	65	100	35	65
4-5	60	5	55	80	20	60
5-6	50	15	35	10	5	5
6-7	85	10	75	100	15	85
7-8	235	40	195	260	50	210
AVERAGE	340	60	280	297	50	250

TABLE 14.

SETTLEABLE SOLIDS										
HOUR	MONDAY OCT. 1.					THURSDAY OCT. 4.				
	WEIGHT P.P.M.			VOLUME C.C.		WEIGHT P.P.M.			VOLUME C.C.	
	TOTAL	FIXED	VOLATIL	1-HR.	2-HR.	TOTAL	FIXED	VOLATIL	1-HR.	2-HR.
8-9 AM	270	80	190							
9-10	250	70	180	9.0	10.0	220	50	170	11.0	9.0
10-11	250	50	200	11.0	12.0	225	50	175	10.0	9.5
11-12	210	45	165	14.0	14.0	195	35	160	8.5	9.0
12-1 PM	200	45	155	2.0	14.0	155	25	130	7.0	6.5
1-2	200	45	155	9.0	9.0	170	35	135	5.0	5.0
2-3	150	30	120	8.5	8.5	150	25	125	7.5	8.0
3-4	205	45	160	8.0	9.5	160	40	120	7.0	7.0
4-5	190	40	150	10.0	11.0	145	25	120	8.0	7.5
5-6	150	30	120	7.5	7.0	165	35	130	9.0	8.5
6-7	160	30	130	10.5	10.5	155	35	120	9.0	8.5
7-8	175	40	135	8.0	7.5	175	35	140	7.5	8.0
8-9	230	40	190	9.0	9.5	185	35	150	8.5	8.0
9-10	260	50	210	8.0	9.0	255	35	220	9.0	10.0
10-11	170	30	140	9.0	9.5	120	25	95	6.0	6.5
11-12	135	30	105	6.0	5.5	155	30	125	10.5	9.5
12-1 AM	120	25	95	5.0	5.0	85	15	70	5.0	4.5
1-2	45	10	35	1.5	1.5	65	15	50	5.5	5.5
2-3	35	10	25	1.5	1.5	55	15	40	3.5	2.5
3-4	20	5	15	0.8	0.8	25	5	20	1.5	1.0
4-5	25	10	15	1.6	1.6	25	5	20	1.0	1.5
5-6	20	5	15	1.8	1.5	15	5	10	0.5	0.5
6-7	40	10	30	2.5	2.5	30	5	25	1.0	1.5
7-8	150	45	105	6.0	5.5	70	20	50	3.0	-
AVERAGE	150	35	115	7.0	7.2	130	25	105	6.3	6.3

DIAGRAM 23.

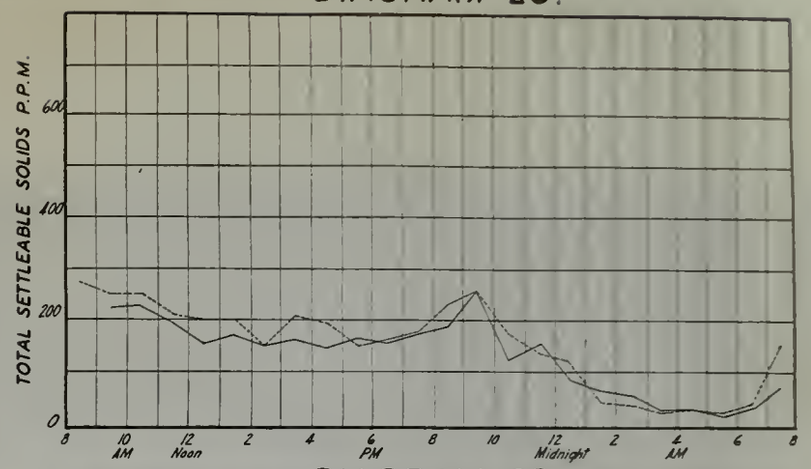
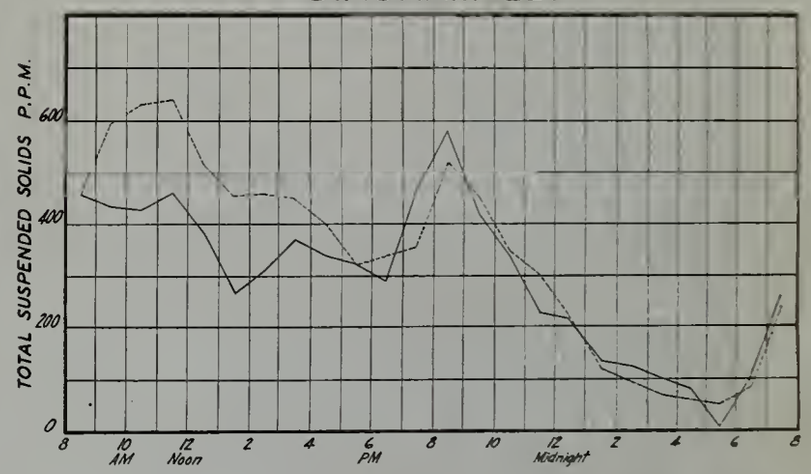


DIAGRAM 22.



Note: B.O.D. Tests made at times of high and low flows gave results approximately equal to the total suspended solids in P.P.M.
"C.C." means cubic centimeters per litre as settled in Imhoff cones.

TABLE 15.

CHLORINE DEMAND P.P.M.				
HOUR	RAW SEWAGE		SUPERNATANT LIQUOR Settled 2 hours	
	MON. OCT. 1.	THUR. OCT. 4.	MON. OCT. 1.	THUR. OCT. 4.
8-9 AM	12.7	15.4	8.1	
9-10	14.8	7.2	10.5	10.5
10-11	15.5	7.5	10.6	6.1
11-12	9.6	7.2	6.5	5.1
12-1 PM	9.9	6.7	6.9	5.1
1-2	9.3	5.5	8.9	4.7
2-3	13.5	5.1	7.4	4.2
3-4	12.0	6.3	6.9	4.2
4-5	9.2	3.9	7.1	3.1
5-6	7.0	4.3	6.7	4.3
6-7	6.7	4.3	5.5	1.8
7-8	6.8	4.5	7.0	2.5
8-9	7.0	5.5	6.6	4.2
9-10	7.4	7.8	5.8	2.1
10-11	6.5	4.7	6.0	4.3
11-12	7.4	5.3	5.4	5.7
12-1 AM	6.0	6.3	5.3	8.7
1-2	6.2	5.2	3.9	5.6
2-3	4.4	4.9	3.0	5.4
3-4	3.0	2.6	3.5	1.7
4-5	3.9	2.3	2.6	2.3
5-6	4.3	1.4	1.7	1.4
6-7	4.3	2.5	2.1	2.4
7-8	9.3	8.1	5.7	6.0
AVERAGE	8.2	5.6	6.0	4.0

DIAGRAM 25.

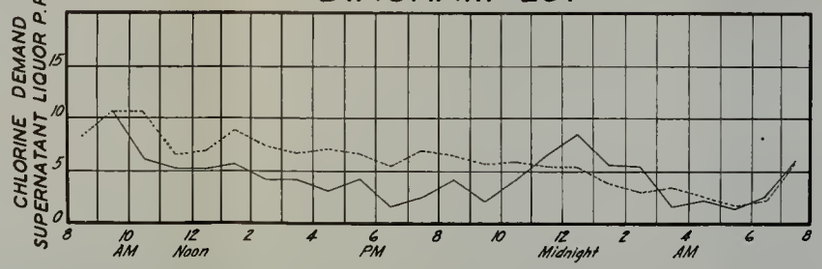
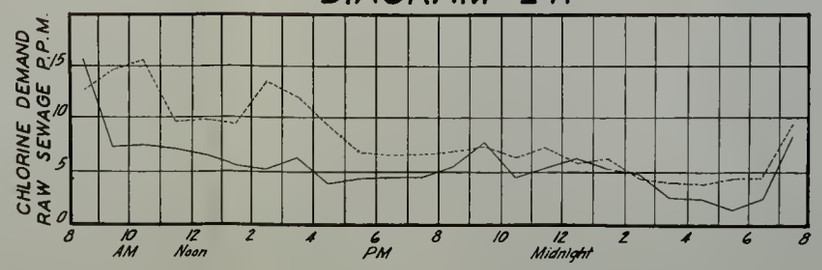


DIAGRAM 24.



LEGEND

Monday Oct. 1, 1934 ----------

Thursday Oct. 4, 1934 ———

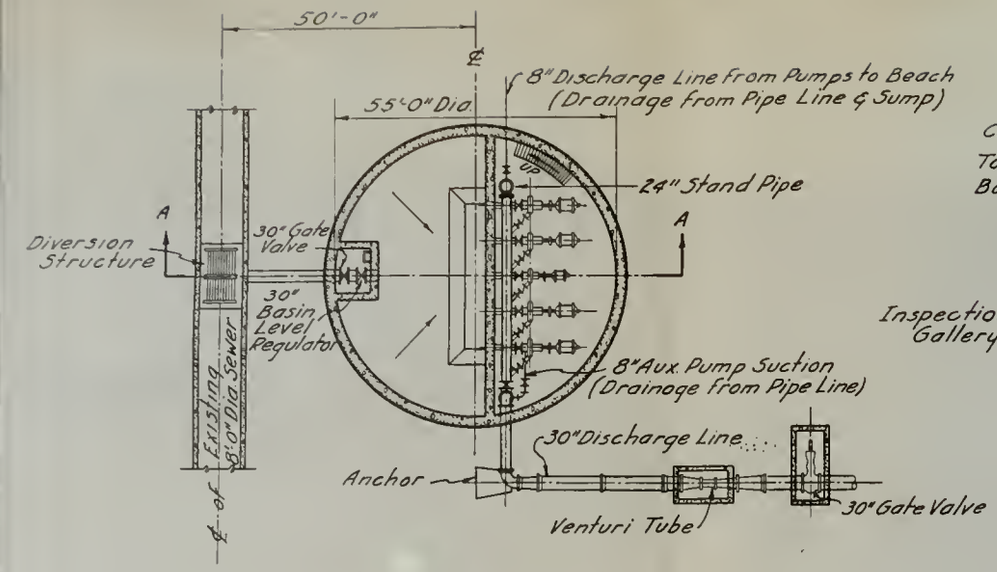
CITY AND COUNTY OF SAN FRANCISCO
DEPARTMENT OF PUBLIC WORKS
BOARD OF CONSULTING SANITARY ENGINEERS
H. P. EDDY, Chairman. C. G. HYDE, Secretary.
L. B. REYNOLDS C. C. KENNEDY

SEWAGE CHARACTERISTICS

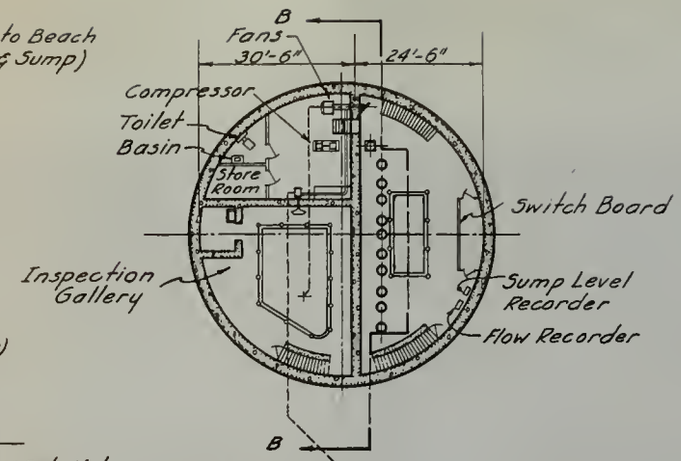
MARINA SUB-DISTRICT.

DRAWN BY R.H.O.	SCALE:	DATE April 1935	FILE A-11.005
TRACED BY	NO. ..... OF ..... SHEETS		
CHECKED BY B.E.			

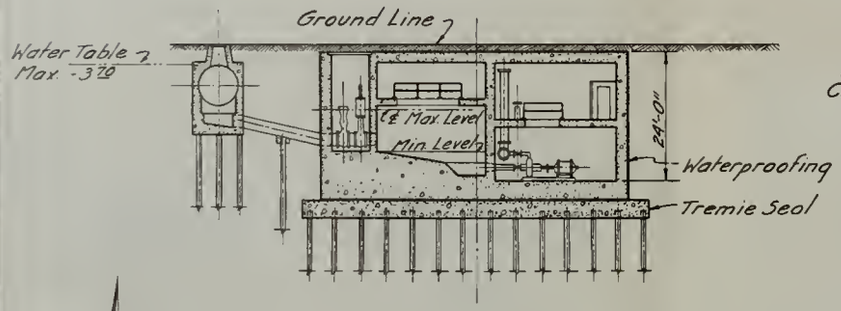
PLATE 45.



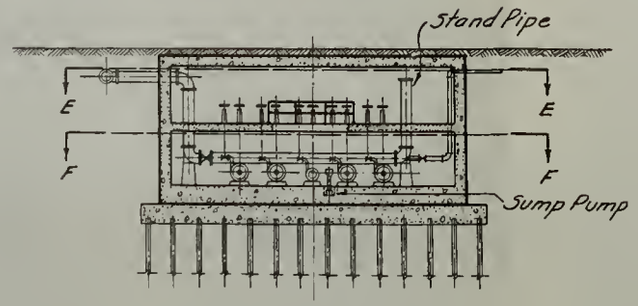
SECTIONAL PLAN F-F



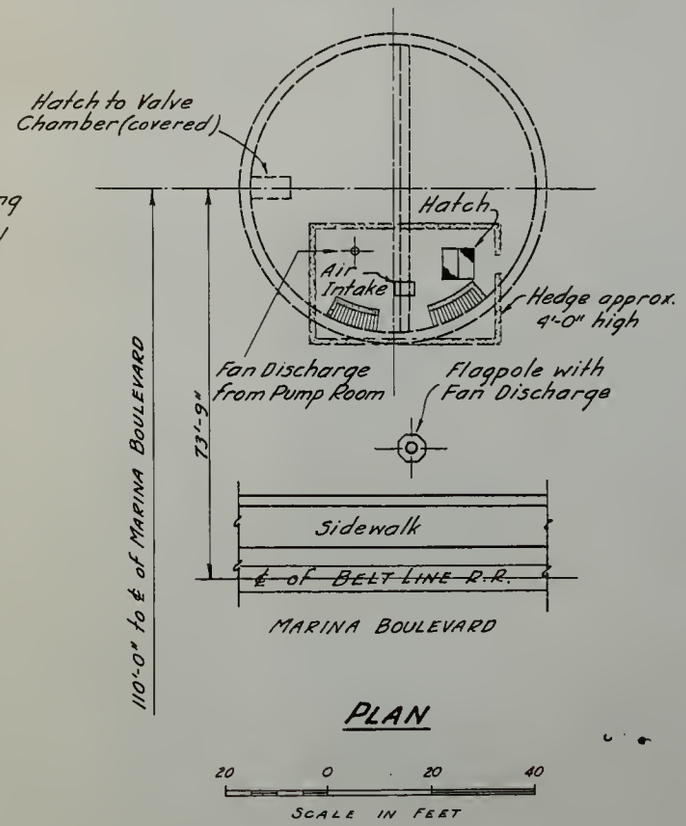
SECTIONAL PLAN E-E



SECTION A-A



SECTION B-B



PLAN

PROVISION FOR

- Diversion Structure and By-pass Line to Sump with hydraulically-operated Basin Level Regulator.
- Gate Valves on Inlet Line and Gate Valves and Check Valves on Discharge Lines of Pumps.
- Gate Valve, Stand Pipe and Venturi Meter on Discharge Line.
- Emergency automatically-operated Gate Valves on Inlet and Discharge Lines to prevent Flooding of station.
- Horizontal non-clogging Sewage Pumps with constant and 2-speed Induction Motors.
- Vertical Sump Pump.
- Switchboard with Oil Circuit Breaker, No-fuse Switches, Starters, Recording and Indicating Instruments, etc.
- Sump Level Recorder arranged for remote Indication to Richmond-Sunset Sewage Disposal Plant and Flow Recorder.
- Float for Pump Control.
- Automatic Heating Equipment.
- Ventilating Equipment with Forced Draft Discharge thru Hollow Flagpole.
- Storeroom, Toilet and Work Shop.

Diagram 26

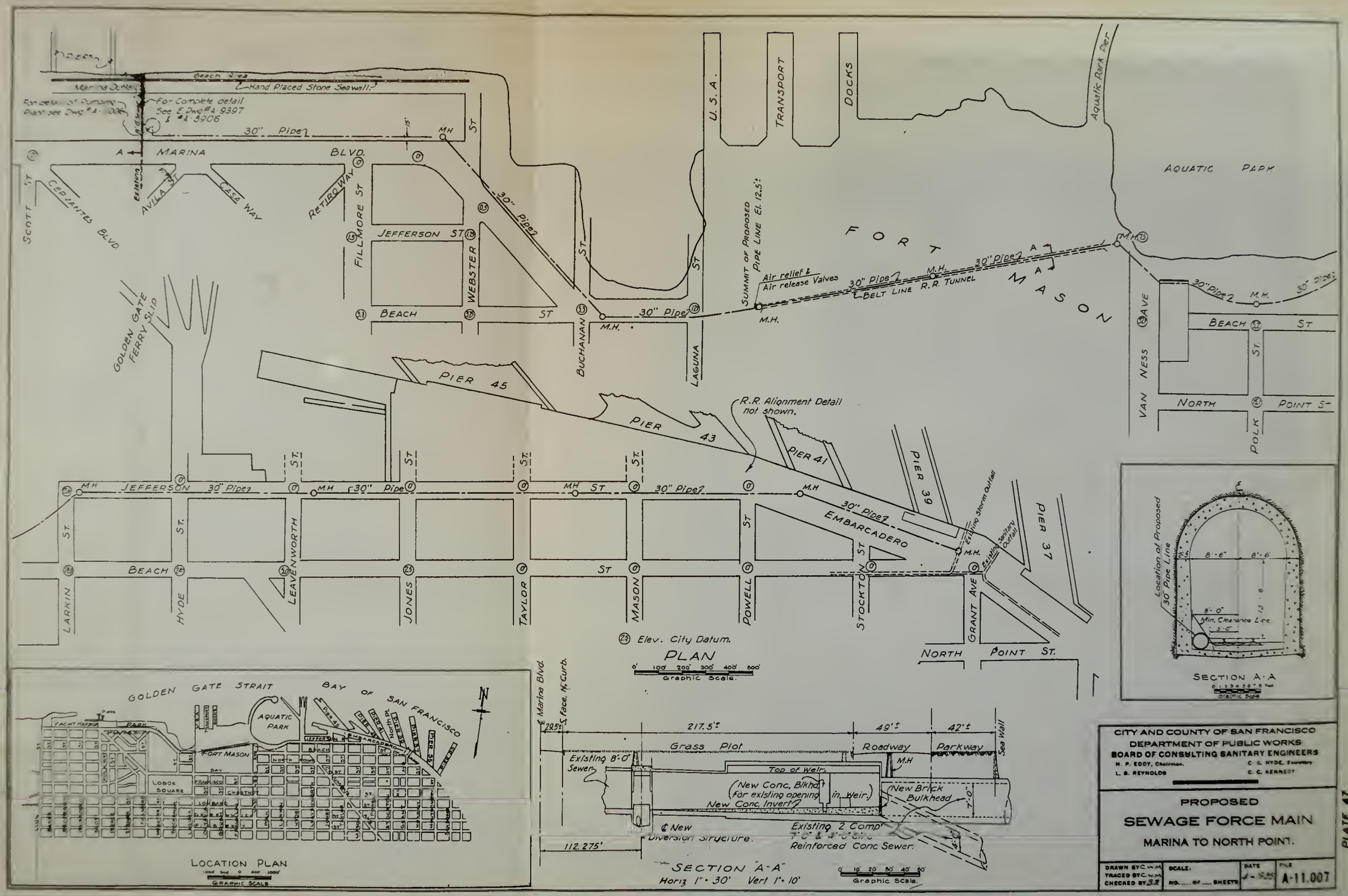
CITY AND COUNTY OF SAN FRANCISCO
DEPARTMENT OF PUBLIC WORKS
BOARD OF CONSULTING SANITARY ENGINEERS
H. P. EDDY, Chairman. C. G. HYDE, Secretary.
L. S. REYNOLDS C. C. KENNEDY

PROPOSED

MARINA SEWAGE PUMPING STATION.

DRAWN BY I.S. TRACED BY A.L.G. CHECKED BY R.B.	SCALE: NO. ..... OF .... SHEETS	DATE April 1935	FILE A-11.006

PLATE 46.

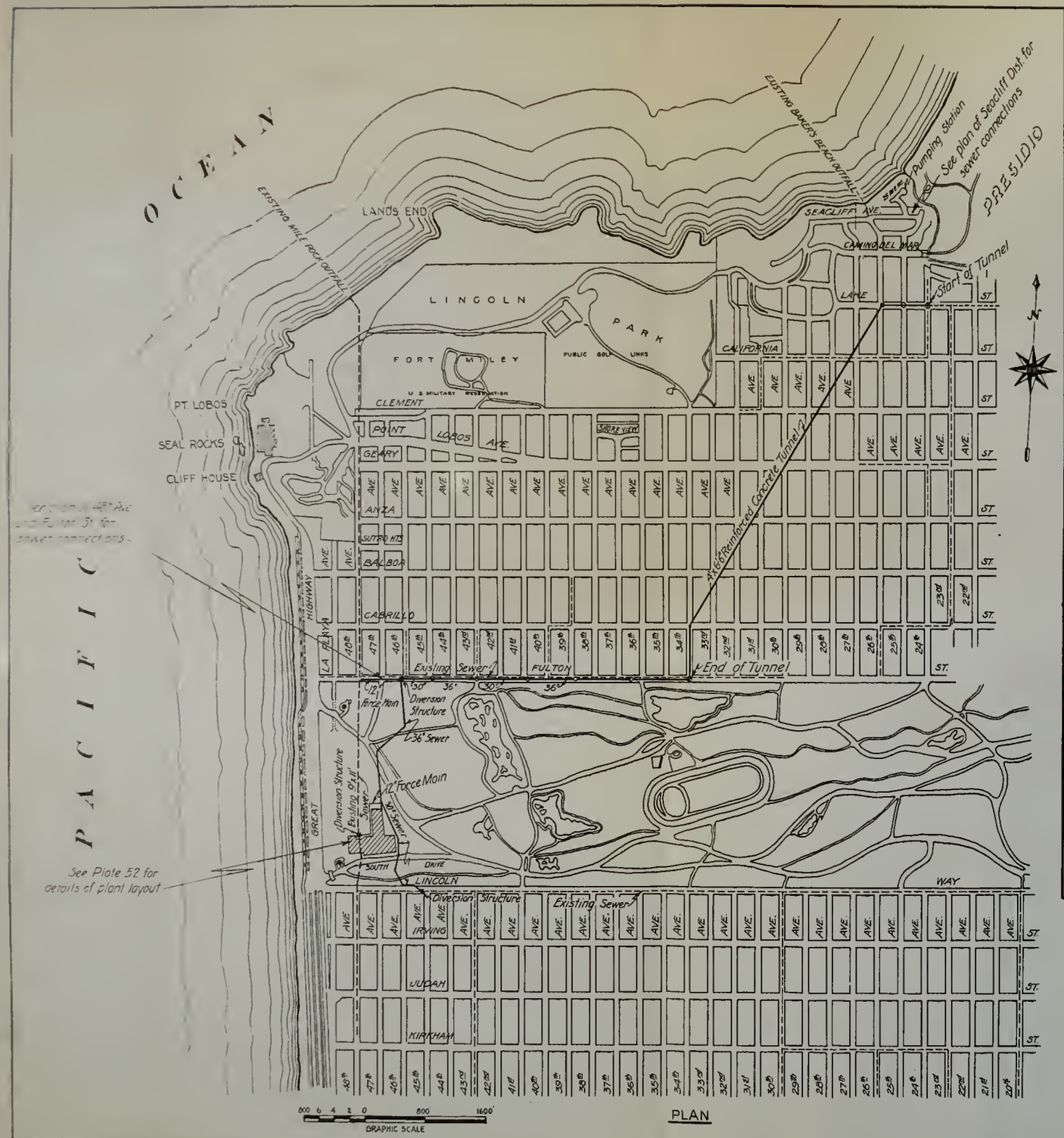


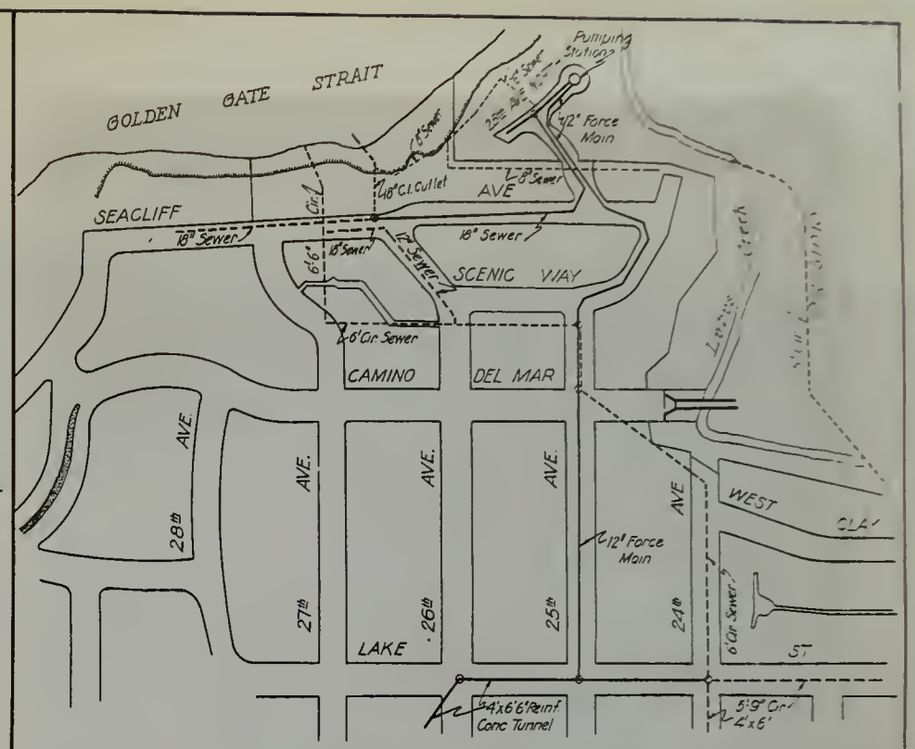
CITY AND COUNTY OF SAN FRANCISCO
DEPARTMENT OF PUBLIC WORKS
BOARD OF CONSULTING SANITARY ENGINEERS
H. P. EDDY, Chairman. C. G. HYDE, Secretary
L. B. REYNOLDS C. C. KENNEDY

PROPOSED
SEWAGE FORCE MAIN
MARINA TO NORTH POINT.

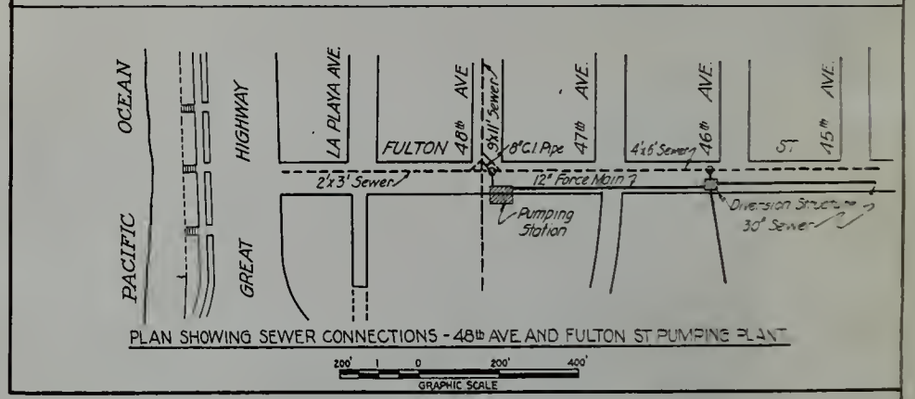
DRAWN BY C. W. M.
TRACED BY C. W. M.
CHECKED BY S. T.
SCALE:
NO. ..... OF ..... SHEETS
DATE 4-1-1905
FILE A-11.007

PLATE 47.





PLAN SHOWING SEWER CONNECTIONS SEACLIFF DISTRICT



PLAN SHOWING SEWER CONNECTIONS - 48th AVE. AND FULTON ST. PUMPING PLANT

LEGEND

Existing Sewers.

Proposed Sewers.

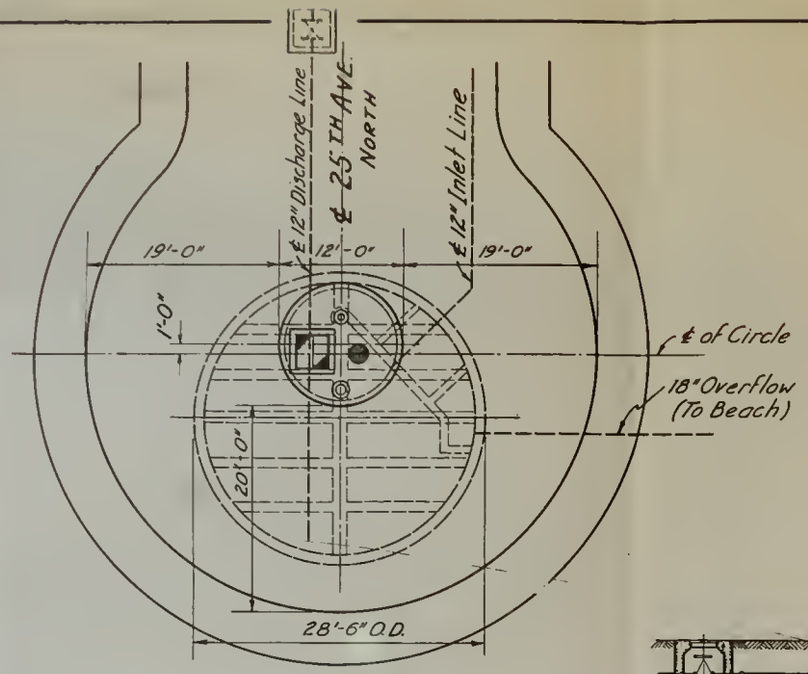
Map 8

CITY AND COUNTY OF SAN FRANCISCO
DEPARTMENT OF PUBLIC WORKS
BOARD OF CONSULTING SANITARY ENGINEERS
H. P. EDDY, Chairman. C. G. HYDE, Secretary
L. B. REYNOLDS C. C. KENNEDY

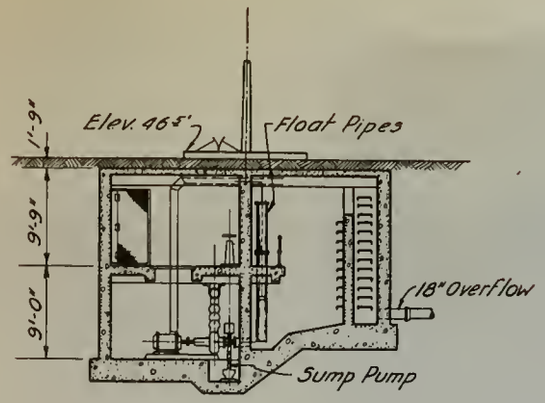
PROPOSED IMPROVEMENTS FOR
MILE ROCK SEWERAGE DISTRICT

DRAWN BY R.T.O.
TRACED BY R.W.J.
CHECKED BY S.S.
SCALE:
NO. OF SHEETS
DATE
FILE A-11,009

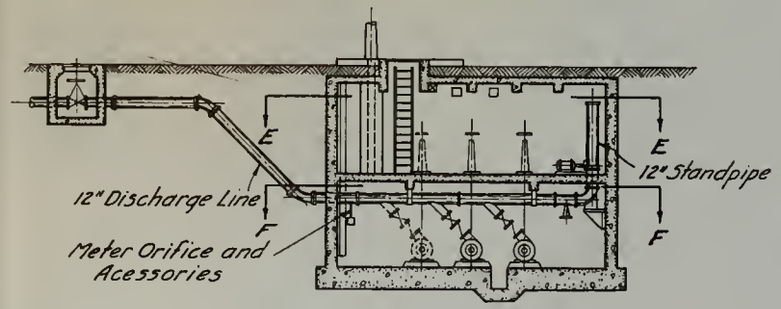
PLATE 46



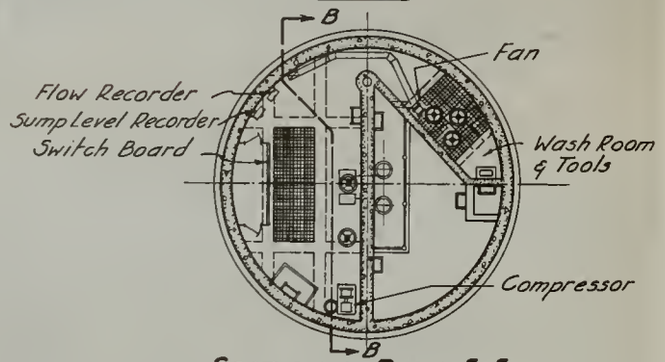
PLAN



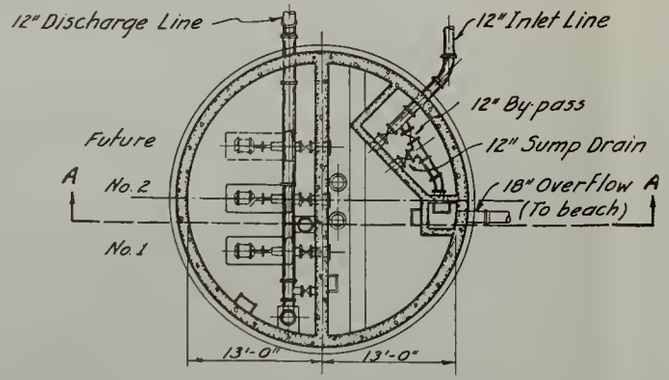
SECTION A-A



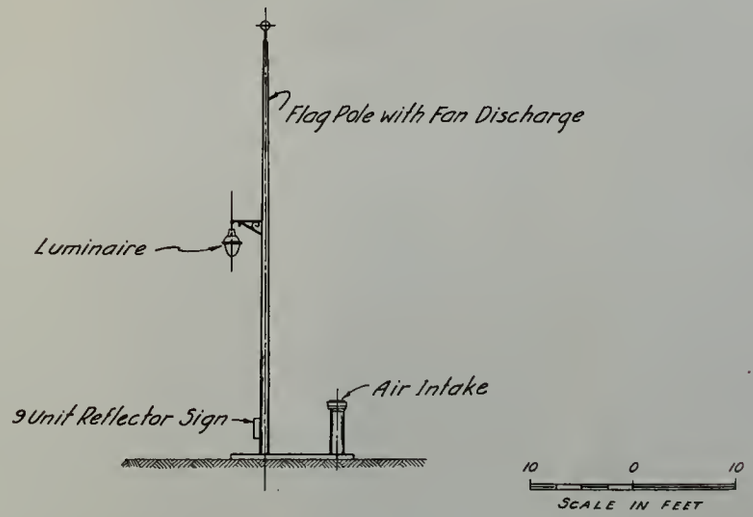
SECTION B-B



SECTIONAL PLAN E-E



SECTIONAL PLAN F-F



ELEVATION ABOVE GROUND

PROVISION FOR

Inlet Line, with By-pass Line and Overflow to Beach.
Drain Line from Sump to Overflow.
Gate Valves on Inlet, By-pass and Drain Lines.
Discharge Line to Tunnel at 25TH Ave. & LAKE ST.
Gate Valve and Standpipe on Discharge Line.
Horizontal nonclogging Sewage Pumps, with Constant Speed Induction Motors.
Vertical Sump Pump.
Switchboard, with No-Fuse Switches, Starters and Recording Instrument, etc.
Sump Level Recorder arranged for remote Indication to Richmond-Sunset Sewage Disposal Plant and Flow Recorder.
Floats for Pump Control.
Automatic Heating Equipment.
Ventilating Equipment with Forced Draft Discharge thru Hollow Flagpole.
Raised Concrete Island above ground with Entrances to Sump Compartment and Pump Room; Air Intake and Flagpole.

CITY AND COUNTY OF SAN FRANCISCO
DEPARTMENT OF PUBLIC WORKS
BOARD OF CONSULTING SANITARY ENGINEERS
H. P. EDDY, Chairman. C. G. HYDE, Secretary.
L. S. REYNOLDS C. C. KENNEDY

PROPOSED
TWENTY-FIFTH AVENUE NORTH
SEWAGE PUMPING STATION.

DRAWN BY J.S. TRACED BY A.L.C. CHECKED BY	SCALE: NO.... OF... SHEETS	DATE April 1935	FILE A-11,009

PLATE 49

TABLE 16.

SUSPENDED SOLIDS P.P.M.

HOUR	MON. AUG. 20 TOTAL	FIXED	VOLATILE	TUE. AUG. 21 TOTAL	FIXED	VOLATILE	WED. AUG. 22 TOTAL	FIXED	VOLATILE	THU. AUG. 23 TOTAL	FIXED	VOLATILE	FRI. AUG. 24 TOTAL	FIXED	VOLATILE	SAT. AUG. 25 TOTAL	FIXED	VOLATILE	SUN. AUG. 26 TOTAL	FIXED	VOLATILE	AVERAGE TOTAL	FIXED	VOLATILE
8-9 AM	280	65	215	440	30	410	535	70	465	455	70	385	390	75	315	435	50	385	330	50	280	445	60	385
9-10				625	40	585	640	100	540	530	85	445	570	90	480	415	50	365	375	10	365	530	75	445
10-11	570	60	510	640	130	510	550	100	450	460	65	395	510	70	440	475	60	415	555	25	530	535	75	465
11-12	340	55	285	770	155	615	465	45	420	440	70	370	530	75	455	240	15	225	700	60	640	500	70	430
12-1 PM	500	75	425	585	85	500	445	60	385	410	55	355	465	65	400	535	65	470	715	35	680	520	65	455
1-2	450	30	420	595	25	570	485	60	425	390	55	335	390	40	350	435	60	375	655	85	570	485	60	425
2-3	575	90	485	520	55	465	595	35	560	345	50	295	405	60	345	295	30	260	595	50	545	445	55	395
3-4	420	50	370	325	100	225	510	15	495	395	85	310	400	65	335	240	35	205	620	70	550	415	65	355
4-5	635	90	545	520	70	450	375	15	360	300	50	250	345	45	300	325	50	275	370	50	320	395	55	330
5-6	445	55	390	325	55	270	450	10	440	260	40	220	380	0	380	240	30	210	380	55	325	345	35	310
6-7	380	50	330	240	50	190	440	15	425	530	40	490	345	50	295	180	15	165	315	50	265	345	40	310
7-8	460	60	400	345	45	300	485	35	450	435	75	360	350	35	315	160	10	150	565	60	505	400	45	355
8-9	455	85	370	335	35	300	605	75	530	445	60	385	390	35	355	355	45	310	445	65	380	435	55	375
9-10	490	105	385	345	50	295	720	60	660	305	35	270	420	40	380	380	45	335	420	55	365	440	55	385
10-11	500	65	435	385	55	290	520	70	450	570	70	500	100	15	85	270	30	240	380	65	315	385	55	330
11-12	595	40	555	250	45	205	395	35	360	825	85	740	350	30	320	285	10	275	365	55	310	440	45	395
12-1 AM	325	25	300	235	35	200	410	60	350	165	20	145	235	15	220	320	30	290	380	50	330	300	35	260
1-2	500	90	410	140	25	115	265	70	195	175	25	150	190	10	180	140	10	130	360	65	295	255	40	210
2-3	205	75	130	195	20	175	240	80	160	365	60	305	155	10	145	110	5	105	180	30	150	205	40	165
3-4	240	25	215	100	20	80	225	95	130	580	95	485	135	5	130	85	0	85	130	25	105	215	40	175
4-5	175	10	165	70	15	55	210	90	120	360	55	305	115	10	105	90	0	90	100	20	80	160	30	130
5-6	140	5	135	45	10	35	180	90	90	195	30	165	75	10	65	60	0	60	140	20	120	120	25	95
6-7	100	5	95	250	125	125	185	85	100	90	25	65	80	5	75	60	0	60	230	100	130	140	50	95
7-8	405	70	335	250	100	150	430	110	320	125	15	110	190	15	175	110	10	100	270	25	245	255	50	205
AVERAGE	410	55	355	335	65	270	430	60	370	380	55	325	315	35	275	260	25	230	400	50	350	360	50	310

TABLE 17

SETTLEABLE SOLIDS

HOUR	MON. AUG. 20 WEIGHT TOTAL	P.P.M. FIXED	P.P.M. VOLATILE	VOL. C.C. 1-HR.	VOL. C.C. 2-HR.	TUE. AUG. 21 WEIGHT TOTAL	P.P.M. FIXED	P.P.M. VOLATILE	VOL. C.C. 1-HR.	VOL. C.C. 2-HR.	WED. AUG. 22 WEIGHT TOTAL	P.P.M. FIXED	P.P.M. VOLATILE	VOL. C.C. 1-HR.	VOL. C.C. 2-HR.	THU. AUG. 23 WEIGHT TOTAL	P.P.M. FIXED	P.P.M. VOLATILE	VOL. C.C. 1-HR.	VOL. C.C. 2-HR.	FRI. AUG. 24 WEIGHT TOTAL	P.P.M. FIXED	P.P.M. VOLATILE	VOL. C.C. 1-HR.	VOL. C.C. 2-HR.	SAT. AUG. 25 WEIGHT TOTAL	P.P.M. FIXED	P.P.M. VOLATILE	VOL. C.C. 1-HR.	VOL. C.C. 2-HR.	SUN. AUG. 26 WEIGHT TOTAL	P.P.M. FIXED	P.P.M. VOLATILE	VOL. C.C. 1-HR.	VOL. C.C. 2-HR.	AVERAGE WEIGHT TOTAL	P.P.M. FIXED	P.P.M. VOLATILE	VOL. C.C. 1-HR.	VOL. C.C. 2-HR.
8-9 AM	*280	65	215	10.5	11.0	390	70	320	23	22.5	265	60	205	12.0	12.4	275	55	220	14.0	15.0	265	50	215	14.5	14.5	280	50	230	16.0	20.2	195	30	165	11.0	11.0	280	55	225	14.4	15.2
9-10						365	80	285	15	18.0	380	75	305	17.0	18.0	390	80	315	19.5	19.5	315	65	250	16.0	15.5	270	45	225	16.0	15.5	225	40	185	22.0	19.5	325	65	260	17.6	17.7
10-11	520			25	25	600	110	490	*5.5	*12.0	315	55	260	16.5	16.0	300	55	245	16.5	17.0	215	45	170	11.5	12.5	315	65	250	19.0	19.0	290	50	240	17.5	16.0	345	65	275	17.7	17.6
11-12	255			16	16	515	95	420	*5.6	*14.50	295	65	230	15.0	15.5	225	45	180	14.5	14.5	225	45	180	12.5	13.5	295	50	245	16.0	17.5	410	60	350	18.0	17.5	315	60	265	15.3	15.7
12-1 PM	245			16	16	490	95	395	*5.0	*14.0	355	85	270	16.0	16.5	275	55	220	16.0	16.5	230	40	190	12.0	15.5	250	50	200	14.5	14.0	280	50	230	12.5	12.5	305	60	250	14.5	15.2
1-2	295			16	18	445	75	370	*3.8	*13.0	245	40	205	18.5	19.5				16.5	spilt	195	35	160	9.0	11.0	270	50	220	16.5	15.0	240	40	200	12.0	11.5	280	50	230	14.7	15.0
2-3	270			16	17	215	30	185	1.4	1.4.0	240	35	205	14.0	14.0	165	30	135	9.0	9.0	220	40	180	10.0	10.0	275	30	245	12.5	12.5	100	15	85	3.0	4.0	210	30	170	11.2	11.5
3-4	225			11.5	12	160	65	95	4	5.0	205	30	175	8.5	9.5	155	45	110	7.5	8.0	210	30	180	11.0	11.5	240	40	200	9.5	9.5	315	35	280	18.0	16.0	215	40	175	10.0	10.2
4-5	210			20	21.5	275	60	215	12	12.5	185	30	155	7.5	8.5	160	35	125	13.5	14.0	185	30	155	7.5	8.0	235	25	210	15.0	13.5	200	25	175	9.0	9.0	225	35	170	12.1	12.4
5-6	180			11.5	12	200	40	160	7	8.5	230	35	195	8.5	9.5	155	30	125	7.0	8.0	210	40	170	7.0	8.0	160	20	140	7.5	8.0	130	15	115	6.5	6.5	180	30	150	7.9	8.6
6-7	305			9.5	10	180	30	150	8	8.0	260	75	185	6.0	7.0	180	35	145	7.0	7.5	200	45	155	7.0	7.5	175	25	150	6.5	6.5	160	15	145	7.5	7.5	210	35	155	7.4	7.7
7-8	270			17.5	17.5	195	25	170	8	8.5	160	25	135	6.5	7.0	320	55	265	20.0	23.0	210	35	175	7.5	8.0	230	35	195	13.0	12.5	200	25	175	10.0	11.0	225	35	185	13.1	12.5
8-9	225			13.5	14.5	280	40	240	11	12.0	280	40	240	12.0	12.0	305	50	255	20.0	18.0	260	40	220	10.0	10.0	180	30	150	7.5	8.5	185	15	170	7.5	7.0	245	35	215	11.6	11.7
9-10	305			11.0	11.5	245	35	210	8.5	9.0	225	35	190	8.5	9.5	155	25	130	8.5	7.5	265	45	220	10.0	9.5	220	30	190	8.0	8.5	225	25	200	7.5	7.5	235	30	190	8.9	9.0
10-11	350			21.5	20.0	225	35	190	9.5	10.0	200	30	170	7.5	7.5	310	55	255	30.0	24.5	255	40	215	11.0	10.5	230	30	200	8.5	8.5	225	30	195	8.5	8.5	255	35	205	13.8	12.8
11-12	225			8.5	8.5	190	30	160	6.0	6.5	175	25	150	7.5	8.0	260	40	220	11.5	11.5	180	30	150	7.0	7.5	200	25	175	7.0	7.5	170	15	155	6.5	6.5	200	25	170	7.7	8.0
12-1 AM	140			6.5	7.0	145	20	125	6.0	6.5	180	30	150	7.5	8.0	125	20	105	6.0	6.5	145	20	125	7.5	7.5	135	15	120	6.5	6.5	135	15	120	6.5	6.5	145	20	125	6.7	6.9
1-2	100			*52.0	*36.0	85	10	75	6.0	6.5	55	5	50	2.5	2.8	100	15	85	6.5	6.5	85	10	75	4.5	4.5	120	10	110	6.5	6.5	180	20	160	15.0	13.0	145	10	95	6.8	6.6
2-3	165			17.0	15.0	60	10	50	4.0	4.0	80	15	65	3.5	3.5	280	35	245	34.5	28.0	85	10	70	3.7	4.0	70	5	65	3.5	3.5	75	5	70	4.0	4.0	130	15	95	5.9	5.7
3-4	130			*45.0	*35.0	30	5	25	1.5	1.5	40	5	35	1.8	1.8	415	65	350	65.0	*57.0	70	10	60	4.5	5.0	45	0	45	2.3	2.5	150	10	140	2.0	2.0	140	15	110	2.4	2.6
4-5	160			*39.5	*27.5	50	5	45	2.0	2.0	30	5	25	1.7	1.8	270	40	230	37.5	*30.0	35	5	30	2.2	2.0	30	5	25	1.8	1.9	40	20	20	1.9	2.0	90	15	65	1.9	1.9
5-6	65			10.5	12.0	20	5	15	1.0	1.0	20	5	15	1.5	1.5	130	20	110	*22.0	*17.5	20	0	20	1.5	1.4	20	0	20	1.7	1.6	50	5	45	2.5	2.3	45	5	35	3.1	3.3
6-7	75			8.5	8.5	25	5	20	1.5	1.6	20	0	20	1.5	1.6	40	5	35	3.5	4.0	35	5	30	2.5	2.0	20	0	20	1.0	1.0	40	5	35	3.0	2.3	35	5	25	3.1	3.0
7-8	190			16.0	15.0	120	15	105	6.5	7.0	90	10	80	3.5	3.5	110	15	95	6.5	6.5	110	10	100	5.3	6.0	45	5	40	2.0	2.5	95	15	80	5.3	5.5	110	10	85	6.5	6.6
AVERAGE	245			12.8	13.0	230	40	190	9.0	9.5	190	35	155	8.5	8.9	220	40	180	11.5	10.9	175	30	145	8.1	8.6	180	25	155	9.1	9.3	180	25	155	9.1	8.7	205	35	165	9.8	9.7

* Monday Aug. 27

† Oil in sewage
‡ Flushing Fire Yard } Not included in Weekly Averages. Weekly Averages substituted in determining Daily Average

Note: "CC" means cubic centimeter per litre as settled in Imhoff cones. B.O.D. Tests made at times of high and low flows gave results approximately equal to the total suspended solids in P.P.M.

TABLE 18.

CHLORINE DEMAND P.P.M.

HOUR	RAW SEWAGE MON. AUG. 20	TUE. AUG. 21	WED. AUG. 22	THU. AUG. 23	FRI. AUG. 24	SAT. AUG. 25	SUN. AUG. 26	AVERAGE	SUPERNATANT LIQUOR (Settled 2 hours) MON. AUG. 20	TUE. AUG. 21	WED. AUG. 22	THU. AUG. 23	FRI. AUG. 24	SAT. AUG. 25	SUN. AUG. 26	AVERAGE
8-9 AM		12.7	15.7	26.4	24.7	15.6	18.7	19.0	8-9 AM	10.7	10.8	20.7	18.1	16.2	13.2	15.0
9-10		12.7	15.7	25.4	21.2	17.5	20.2	18.8	9-10	11.4	12.6	19.6	14.5	14.5	16.8	14.9
10-11		18.3	14.2	24.0	16.4	18.0	16.2	17.9	10-11	12.8	13.2	15.1	12.7	14.1	15.2	13.9
11-12		19.6	12.6	16.5	17.9	17.4	15.5	16.4	11-12	10.3	9.1	12.8	13.9	11.8	12.4	11.7
12-1 PM		†37.8	14.4	14.5	15.8	13.3	15.7	14.7	12-1 PM	†24.6	8.3	13.6	12.9	11.2	13.3	11.9
1-2		14.5	10.6	14.8	13.2	13.7	12.7	13.3	1-2	7.8	8.6		10.5	11.3	11.5	9.9
2-3	11.6	11.0	10.4	14.8	†30.4	13.4	12.6	12.3	2-3	9.3	8.0	10.8	†28.5	11.3	10.0	9.4
3-4	13.6	5.3	11.6	15.0	13.1	13.4	13.2	12.2	3-4	4.0	10.1	10.2	10.7	11.3	10.6	8.9
4-5	12.0	11.3	13.2	13.8	11.5	14.0	13.2	12.7	4-5	9.1	9.1	8.9	10.4	10.4	10.4	9.5
5-6		12.1	13.8	12.9		11.0	11.3	12.2	5-6	9.1	10.5	9.1	10.7	8.6	9.1	9.6
6-7	16.0	13.5	12.2	11.0	13.4	11.4	10.5	12.6	6-7	7.6	9.1	8.7	9.9	8.6	8.7	9.0
7-8	11.8	13.1	14.4	13.1	11.3	12.3	12.6	12.7	7-8	9.8	11.7	9.8	9.3	8.9	9.6	9.4
8-9	11.0	14.5	12.6	12.8	16.4	11.1	11.4	12.8	8-9	8.4	9.5	9.7	15.3	8.6	10.8	9.7
9-10	11.2	10.1	12.6	13.2	12.1	12.0	13.7	12.1	9-10	9.0	10.8	11.1	10.4	9.4	10.9	10.3
10-11	10.2	11.7	11.6	13.5	10.7	15.2	12.6	12.2	10-11	8.5	10.3	11.3	11.3	9.3	10.3	10.1
11-12	8.9	9.6	12.1	11.9	12.3	10.4	14.3	11.3	11-12	7.3	9.5	9.3	9.4	8.4	9.3	9.0
12-1 AM	10.6	9.0	10.7	11.4	11.5	9.4	14.7	11.0	12-1 AM	7.0	9.7	11.2	11.3	9.3	9.3	9.2
1-2	12.2	7.9	13.2	12.8	11.4	11.7	13.1	11.8	1-2	6.7	9.7	11.1	11.1	9.5	11.3	9.3
2-3	6.9	7.1	9.8	11.5	11.4	11.4	9.4	9.6	2-3	6.7	8.5	11.4	11.0	11.2	9.3	9.2
3-4	6.9	5.2	8.8	11.9	9.5	9.8	9.0	8.7	3-4	4.8	8.7	10.3	9.0	9.8	7.9	8.1
4-5	5.9	5.3	7.7	11.3	9.8	9.8	7.2	8.1	4-5	4.0	6.9	10.0	7.5	9.1	7.4	7.0
5-6	4.5	5.3	7.0	7.0	9.3	10.9	6.9	7.3	5-6	3.6	6.1	7.0	8.8	8.9	4.2	5.9
6-7	4.5	3.3	7.3	8.6	7.5	9.3	6.5	6.7	6-7	3.4	2.7	7.3	5.2	6.3	7.2	4.7	5.3
7-8	9.6	9.4	11.3	13.6	9.5	11.1	10.6	10.7	7-8	8.7	8.7	10.3	10.8	9.3	10.7	10.2	9.8
AVERAGE	9.8	10.7	11.8	14.2	13.1	12.6	12.6	12.3	AVERAGE	7.1	8.0	9.5	11.2	11.0	10.4	10.3	9.7

† See note under Table 17.

DIAGRAM 28.

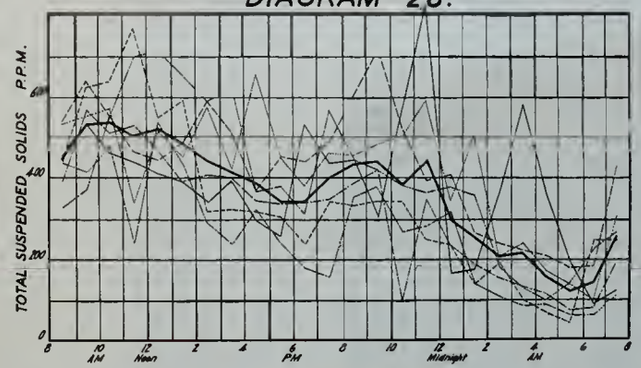


DIAGRAM 29.

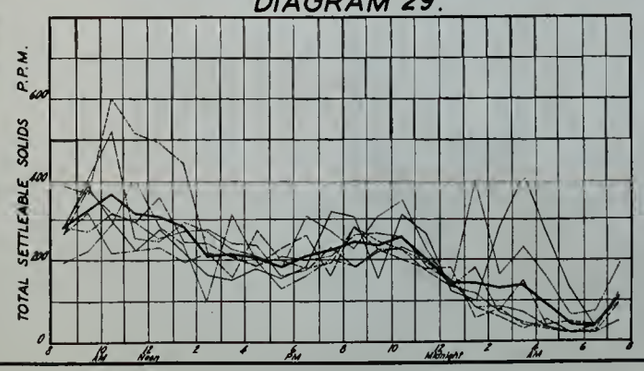


DIAGRAM 30.

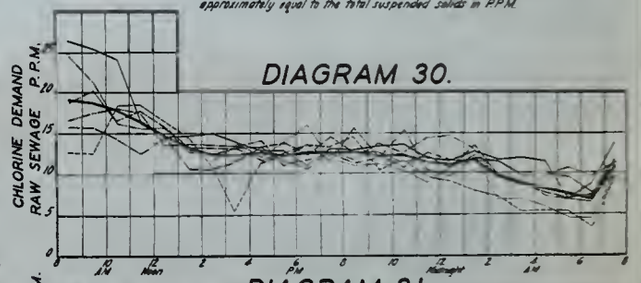
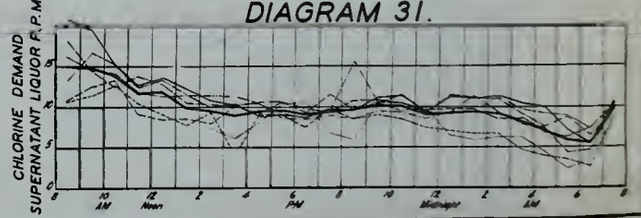


DIAGRAM 31.



LEGEND

- Sunday Aug. 26.1934
- Monday " 20
- Tuesday " 21
- Wednesday Aug. 22
- Thursday " 23
- Friday " 24
- Saturday " 25
- Average

CITY AND COUNTY OF SAN FRANCISCO
DEPARTMENT OF PUBLIC WORKS
BOARD OF CONSULTING SANITARY ENGINEERS
H. P. BODY, Chairman — C. G. HYDE, Secretary
L. B. REYNOLDS — C. C. KENNEDY

SEWAGE CHARACTERISTICS

BAKER'S BEACH SUB-DISTRICT.

SURVEYED RHO. TRACED BY CHECKED BY — SCALE — NO. OF SHEETS — DATE April 1935 — FILE A-11,010

PLATE 60

TABLE 19.

SUSPENDED SOLIDS P.P.M.						
HOUR	MONDAY AUG. 27.			THURSDAY AUG. 30.		
	TOTAL	FIXED	VOLATIL	TOTAL	FIXED	VOLATIL
8-9 AM	785	195	550	480	80	400
9-10	525	80	445	500	80	420
10-11	655	110	545	720	180	540
11-12	515	30	485	620	110	510
12-1 PM	680	85	595	650	90	560
1-2	700	70	630	480	95	385
2-3	525	65	490	415	55	360
3-4	450	50	400	460	25	435
4-5	450	35	415	425	25	400
5-6	405	60	345	365	35	330
6-7	270	35	235	400	0	400
7-8	380	60	320	400	25	375
8-9	335	40	295	390	25	365
9-10	360	20	340	350	5	345
10-11	455	40	415	445	15	430
11-12	410	35	375	595	25	570
12-1 AM	395	40	355	425	10	415
1-2	255	30	225	330	10	320
2-3	205	35	170	265	10	255
3-4	230	5	225	220	5	215
4-5	90	10	80	180	20	160
5-6	145	10	135	215	15	200
6-7	40	0	40	100	10	90
7-8	115	5	110	145	15	130
AVERAGE	390	50	340	400	40	360

TABLE 20.

SETTLEABLE SOLIDS										
HOUR	MONDAY AUG. 27.					THURSDAY AUG. 30.				
	WEIGHT P.P.M			VOLUME C.C.		WEIGHT P.P.M.			VOLUME C.C.	
	TOTAL	FIXED	VOLATIL	1-HR.	2-HR.	TOTAL	FIXED	VOLATIL	1-HR.	2-HR
8-9 AM	430	105	325	20.5	20.5	475	80	395	20.5	20.0
9-10	420	90	330	19.5	19.5	305	10	295	20.5	19.5
10-11	515	110	405	20.0	19.5	485	110	375	25.0	22.0
11-12	435	80	355	22.0	22.5	515	155	360	18.5	17.0
12-1 PM	345	70	275	25.0	24.5	360	65	295	22.5	20.0
1-2	455	75	380	26.0	24.5	360	85	275	16.5	16.0
2-3	410	20	390	26.0	25.0	270	40	230	16.0	15.0
3-4	280	10	270	16.0	16.5	245	35	210	13.0	13.5
4-5	290	80	210	15.0	15.5	230	30	200	13.5	13.0
5-6	345	55	290	15.5	15.0	210	30	180	11.5	11.0
6-7	240	40	200	11.5	12.0	235	35	200	9.5	10.0
7-8	275	45	230	13.0	13.0	270	45	225	11.0	10.5
8-9	235	40	195	12.0	10.0	245	40	205	11.0	11.0
9-10	225	35	190	10.0	10.0	290	45	245	15.0	15.0
10-11	315	45	270	13.0	12.0	330	45	285	18.0	16.0
11-12	260	30	230	12.0	12.0	310	40	270	14.0	12.5
12-1 AM	275	40	235	12.0	11.0	275	25	250	14.5	14.0
1-2	210	35	175	12.0	10.5	195	30	165	8.5	8.5
2-3	140	20	120	6.5	7.0	75	10	65	8.0	8.0
3-4	125	15	110	6.0	5.7	180	25	155	4.5	9.0
4-5	85	15	70	5.5	5.5	80	15	65	4.5	4.0
5-6	55	10	45	2.0	2.0	50	10	40	3.3	3.5
6-7	30	10	20	1.6	1.6	30	5	25	2.3	2.0
7-8	50	5	45	2.5	3.0	70	5	65	6.5	6.0
AVERAGE	270	45	225	13.5	13.3	255	45	210	12.8	12.4

DIAGRAM 33.

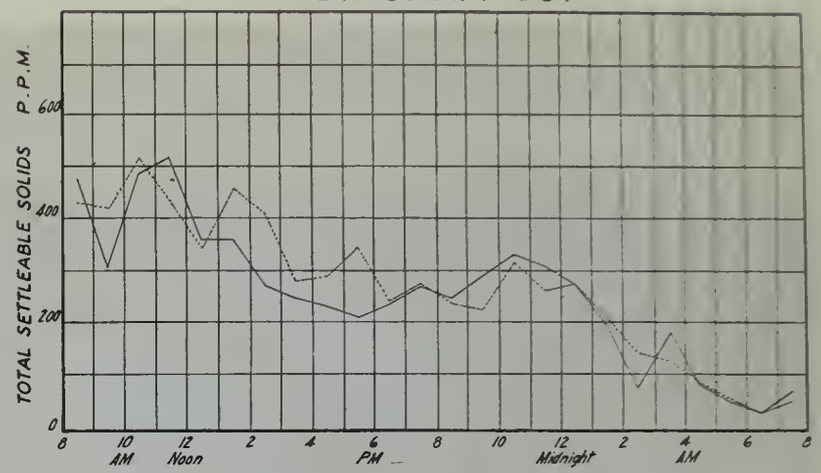
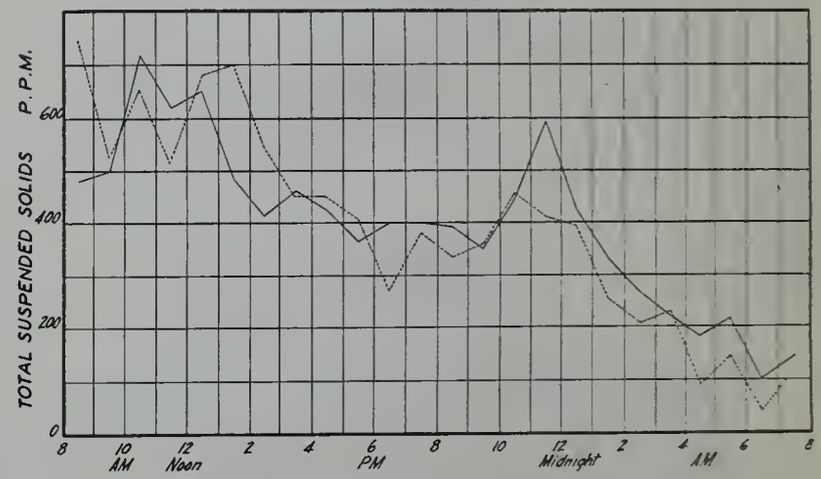


DIAGRAM 32.



Note: B.O.D. Tests made at times of high and low flows gave results approximately equal to the total suspended solids in P.P.M. "C.C." means cubic centimeters per litre as settled in Imhoff cones.

TABLE 21.

CHLORINE DEMAND P.P.M.				
HOUR	RAW SEWAGE		SUPERNATANT LIQUOR Settled 2 hours	
	MON. AUG.27	THUR. AUG.30	MON. AUG.27	THUR. AUG.30
8-9 AM	11.0	14.0	10.6	12.0
9-10	11.8	13.3	9.6	9.9
10-11	10.1	14.8	10.1	11.1
11-12	11.5	12.5	8.3	10.4
12-1 AM	9.9	11.1	8.6	9.2
1-2	9.7	9.7	7.5	9.8
2-3	8.7	8.2	7.8	7.7
3-4	8.4	10.5	6.4	8.4
4-5	9.7	8.5	7.6	8.0
5-6	9.0	10.5	7.1	7.8
6-7	8.5	8.4	6.7	8.0
7-8	8.9	9.2	8.4	7.9
8-9	8.9	9.2	8.4	7.9
9-10	9.1	10.0	7.6	8.2
10-11	10.4	11.6	8.1	10.2
11-12	9.5	8.0	8.3	7.3
12-1 AM	8.8	6.8	7.4	4.7
1-2	8.3	8.9	5.8	4.4
2-3	6.8	4.7	5.1	4.5
3-4	4.7	4.6	4.7	3.5
4-5	4.8	3.5	4.2	4.0
5-6	3.6	3.4	2.8	2.5
6-7	3.3	2.4	2.4	2.5
7-8	4.6	2.5	3.7	2.3
AVERAGE	8.3	8.7	7.0	6.9

DIAGRAM 35.

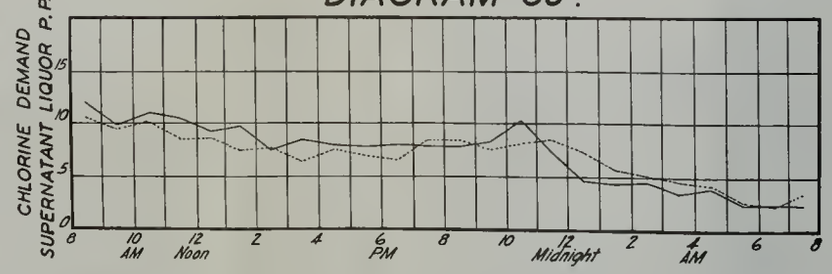
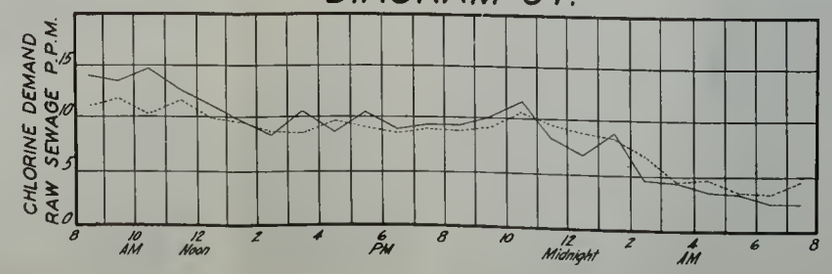


DIAGRAM 34.



LEGEND

Monday Aug.27,1934 .....

Thursday Aug.30,1934 ———

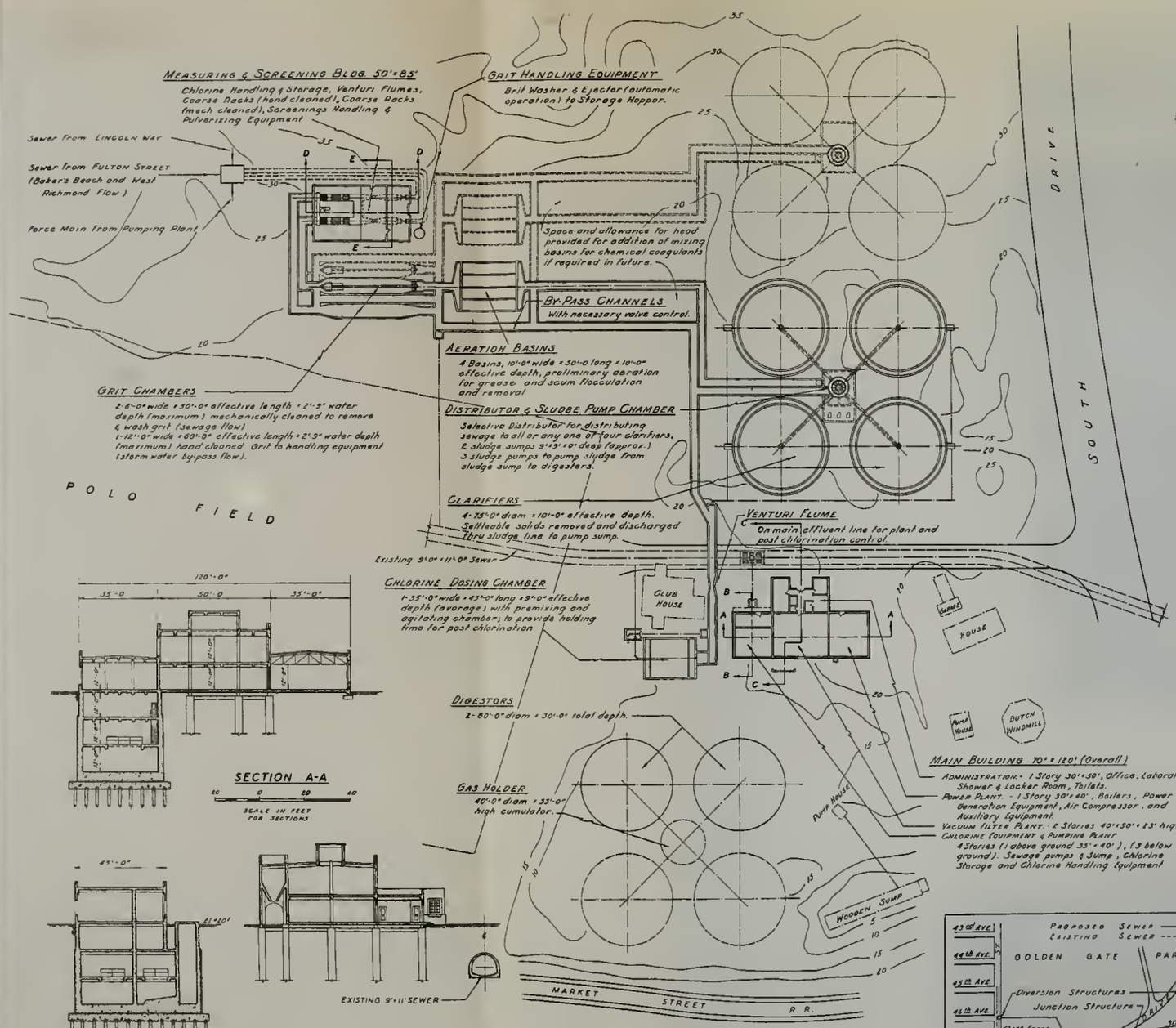
CITY AND COUNTY OF SAN FRANCISCO
DEPARTMENT OF PUBLIC WORKS
BOARD OF CONSULTING SANITARY ENGINEERS
H. P. EDDY, Chairman. C. G. HYDE, Secretary.
L. B. REYNOLDS C. C. KENNEDY

SEWAGE CHARACTERISTICS

SUNSET SUB-DISTRICT.

DRAWN BY R.H.O. TRACED BY CHECKED BY B.B.	SCALE: NO. ..... OF ..... SHEETS	DATE April 1935	FILE A-11.011

PLATE 51



NOTES

Connecting pipe lines and drains not all shown
Valves for pipe lines and channels not shown.
Ground elevation for the plant except digesters to be approximately Elev. +22.4
The digesters to be installed below ground surface. Grass covering to be approximately at Elev. +27.9
Plant layout made for estimating purposes and might be altered in final design.

LEGEND

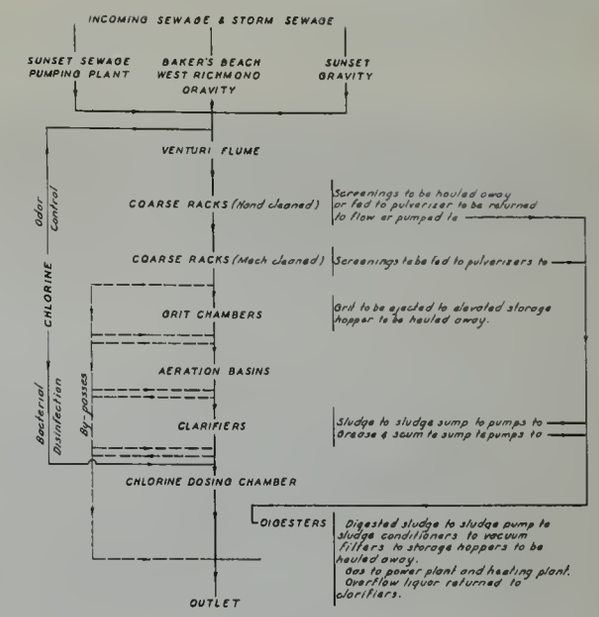
Present proposed plant structures
Future proposed plant structures.
Existing park structures.

GENERAL ARRANGEMENT

SCALE IN FEET

Diagram 36

FLOW DIAGRAM



NOTE
During storms the plant can be operated at a rate considerably in excess of its normal capacity to provide less complete treatment for the larger flow.

Table 22

ASSUMED BASIC DESIGN FACTORS

			Initial Design	Ultimate
FLOWS				
Baker's Beach	Average Sewage	(M G D)	8.0	18.0
	Maximum "	"	18.0	20.0
	Maximum Storm	"	30.0	300
West Richmond	Average Sewage	"	7.0	17.0
Sunset	Maximum "	"	11.2	25.0
	Maximum Storm	"	25.0	47.0

RACKS
One for Sanitary Sewage & one for Storm Sewage to handle 30 M G D

GRIT CHAMBERS
Two for Sanitary Sewage & two for Storm Sewage proportioned to provide a maximum velocity of 1.25 feet per second at a flow of 30 M G D

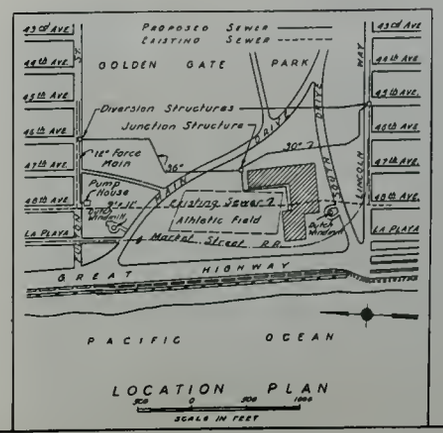
AERATION BASINS
Four Basins proportioned to provide a combined detention period of 2 hours at 15 M G D

CLARIFIERS
Four Clarifiers proportioned to provide a combined detention period of 2 hours at 15 M G D

DIGESTERS
Four Digesters proportioned to provide a combined detention period of 30 days plus 10 day storage for sludge from a flow of 15 M G D

CHLORINE EQUIPMENT
Equipment provided to treat a flow of 15 M G D with a maximum average dosage of 12 P P M split for pre-chlorination for odor control and post chlorination for bacterial disinfection. Dosing chamber for post chlorination to provide 10 minute holding time at 15 M G D rate

VACUUM FILTER EQUIPMENT
To handle sludge from digesters in 8 hour operating period.



LOCATION PLAN

SCALE IN FEET

CITY AND COUNTY OF SAN FRANCISCO
DEPARTMENT OF PUBLIC WORKS
BOARD OF CONSULTING SANITARY ENGINEERS
H. P. EDDY, CHAIRMAN — G. G. OTTEN, ENGINEER
L. S. METCALF — G. C. SEARLES

PROPOSED
RICHMOND - SUNSET
SEWAGE TREATMENT PLANT.

DRAWN BY B.J.K. — TRACED BY J.S. — CHECKED P.L.R. — SCALE: — DATE — FILE 0-11,012

PLATE 62

OK

APPENDIX I

GEOLOGICAL SURVEY

of the

AREA OF THE PROPOSED TUNNEL

FROM BAKER'S BEACH TO LANDS END

and

FROM A SHORE POINT SOUTH OF MILE ROCK TO LANDS END

GEOLOGICAL SURVEY OF THE AREA OF THE PROPOSED TUNNELS FROM BAKER'S BEACH TO LANDS END AND FROM A SHORE POINT SOUTH OF MILE ROCK TO LANDS END

The present discussion has to do with the area, along the south shore of the entrance to San Francisco Bay, from a point due south of Mile Rock Lighthouse to the Sea Cliff subdivision.

The study of this area has been made to determine the feasibility of locating a sewerage settling and digestion plant in the cove near Lands End, and, to determine the feasibility of driving tunnels, for the delivery of sewage, through the hills from Sea Cliff and from the outfall of the 48th Avenue sewer, to connect with such a plant.

The present system of disposal by which open sewers discharge into the Bay along its shore line, has been found unsatisfactory because of the refuse which collects on the beaches.

The peninsula of San Francisco rises within this area, to an elevation with a maximum of not over four hundred feet above sea level.

The surface of this rise, in keeping with the general westerly, coastal slope of the peninsula is covered with a heavy overburden of sand and soil.

This covering obscures the underlying formations except as these are exposed by excavation or by natural erosion.

The shore line, from Mile Rock to Sea Cliff, with the exception of two short intervals, is marked by a narrow tidal beach.

The rise from this beach is abrupt. The lower reaches

being cliffs of irregular height which at elevation of from a few feet to one hundred feet above sea level, round off to steep slopes which continue upward until the final modification in slope occurs at the hill top.

A fairly complete section of the rock formations immediately underlying the area, is exposed in the cliffs and steep hillsides of this slope.

I have studied the exposed rocks, and at points distant from the shore line have obtained additional data on the formations from the records of drill holes, wells, building excavations, street grading cuts, and railroad rights-of-way.

The United States Geological Survey in 1915, published the San Francisco Folio (Folio 193), of the Geologic Atlas of the United States.

This Folio deals with the area we are discussing and describes the rocks exposed here as sediments of the Franciscan group, together with certain associated volcanic rocks. It places the horizon of the exposed sediments so that there are included some of the upper members of the Marin Sandstone formation and some of the lower members of the overlying Ingleside Chert formations.

I have, in writing this statement, adhered to the names of formations as used in this Folio. I would refer anyone to this Folio for a more general geologic study of the Bay Region.

STATEMENT OF GEOLOGIC CONDITIONS PERTINENT TO THE PRESENT STUDY

The prevailing rock of the Marin Sandstone formation "is a massive, obscurely bedded sandstone of dark greenish-gray color and medium texture.
"Although these sandstones are prevailingly massive, significant glimpses of their bedding, obtained at many places show that they are normally stratified. The bedding in these places is usually made apparent by intercalated beds of shale rather than by any notable difference from horizon to horizon in the character of the sandstones themselves."

There is, exposed in this area near Lands End, one horizon in the Marin Sandstone formation which must be carefully considered in a study of the proposed plant site. This horizon, which is here found immediately underlying the Ingleside Chert, is not the massive sandstone characteristic of the formation, but consists of approximately a seventy-five foot thickness of interbedded strata of sandstone and shale. (Note--measurement obtained where Camino del Mar crosses formation in Lincoln Park). The shale is blue black in color and when wet works up into a slippery mud which runs easily. It is this characteristic of the shale which has made the strata of this material become mud slippage planes along which whole sections of the overlying hill have moved whenever the moisture conditions, the fracturing of the formations, and the undermining action of the waves have jointly brought about the proper conditions.

The fracturing, which has weakened the formations and thus helped to make feasible the slides, has resulted from the readjustment attendant on the intrusion, into the Franciscan sediments, of igneous rock masses and from later faulting.

The igneous rocks are at present represented by bodies of serpentine. Two outcrops of this material can be traced in the immediate vicinity of Lands End. The first, which outlines the western limit of the flat proposed for the plant site, extends from the beach line, up the hillside through the site of the Lands End Station to a point above, where it is lost under slide material.

The second outcrop is found at the beach line 900 feet to the east of the one just discussed. It continues up the hill, with several offsets along lines of faulting, showing near the west portal of the former #2 tunnel of the United Railroads right-of-way.

It can be traced further to the Third Tee of the Lincoln Park Golf Course and is plainly visible above the Camino del Mar in Lincoln Park.

I am preparing a map showing these outcrops together with the general conditions existing in the area of the proposed development.

The hillside area, within which the serpentine outcrops occur, is a moving mass of slide material which for years has been slowly shifting down to the shore line. There are several reports in the files of the City Engineer's office which bear on the history of these slides.

The position in the slide, of rock fragments, derived from the several characteristic formations, is a somewhat hazy suggestion of the position of these formations before the slides took place.

A study of the surface exposures of rock formations in place in this vicinity, together with the evidence of test boring, building excavations, grading cuts, and the modified evidence of the slides, makes it certain that the cliffs and steep side hills along the shore line expose the eroded edges of the sediments; that the general strike of these edges is easterly and westerly, and that there is a slight (from five to fifteen degrees from the horizontal) general inclination of the sedimentary strata to the south.

There has been a local distortion or folding of the strata which has modified the strike and dip in accordance with the anticlinal or synclinal nature of the fold.

The folds extend in a direction such, that the axis of folding has a general southeasterly strike. I have recorded strikes varying from S.30°E, to S.48°E.

The characteristic massive sandstone of the Marin formation has not yielded readily to distortion, and the folding, in this material, has been accomplished by block faulting in which the displacement of the blocks has outlined the direction of the fold.

The overlying thin-bedded formations with inter-stratified layers of shale, have yielded more readily to distortion and have followed closely the lines of folding without any great amount of faulting. It is true that the strata of resistant material have been shattered, but these have been held in place by the more elastic layers of shale and the deformation has been accomplished with but slight movement between the individual fragments.

I am preparing a drawing to illustrate the block faulting in the sandstone and the deformation of the overlying formations. This drawing is a vertical section in an East West line as indicated on the accompanying map.

This section shows how the formations have been elevated and depressed during the process of deformation, and the effects of these movements on the coast line; where the massive sandstone stands high above the beach line, we find cliffs and steep bluffs; where the heavy shale strata have been depressed to sea level or below this point, we find a slide area extending back from the shore line.

It must be borne in mind, that there is a general inclination of the formations to the south, and that where the heavy shale strata are found, at, or near, the elevation of the shore line, it is reasonable to expect to find the water soaked shale, in the form of mud, extending back for a considerable distance under the slide area.

A careful study, including considerable test drilling, will be necessary to determine the existence of building foundations under this area, and also to make sure that it can be drained so that the present slide material will remain in place.

Special problems are involved in the question of draining this area. There is the question of the natural precipitation over the area; there is the question of the surface drainage and the seepage from an overburden of sand in the surrounding areas tributary to these slides; there is the question of an underground flow of water in the Chert formation which is exposed in the excavations for the Legion of Honor Memorial Building and at the Veterans' Memorial Hospital Building in Fort Miley; there is the possibility that the shale extends below the elevation of tide level and that seepage of ocean water may occur.

The Cliff House controlled a slide, affecting their resort, by driving a drainage tunnel along a fault slippage plane and draining this. They drilled holes from the surface to this tunnel at intervals, lined the holes with perforated casing to hard rock, and passed the surface run-off and sand seepage down these drains to the tunnel.

Mr. Geo. McLeod, Superintendent for Mr. G. A. Applegarth in the construction of the Legion of Honor Memorial Building, states that a two inch centrifugal pump, working to capacity, was needed to keep the theater excavation under that building free from water which ran in from the Chert strata . Permanent tile drains had to be run through tunnels from this building.

The Maintenance Officer in charge at the Veterans' Memorial Hospital at Fort Miley states that one floor of the main building is excavated in the Chert and that they had to establish drains

to get rid of the water.

These statements indicate that the Chert strata outlining the rim of the slide areas, are the source of a flow of water which passes down into the slide and which must be controlled if slippage is to be stopped.

A certain amount of water is added to the slide area through an existent, septic tank; sewage disposal plant now situated within the area. I have indicated the position of the plant on my map, but presume that it will be done away with if the proposed improvement is carried through.

I have indicated four areas on my map with the letters, A. B. C. D., within which slides are existent.

The proposed plant site is within the area C. The proposed tunnels from Sea Cliff and from the outfall of the 48th Avenue Sewerage tunnel to this Site, would pass through the areas A. B. C. and D.

These slide areas, in their present condition, are not suitable either for the erection and maintenance of the proposed plant, or for the construction and maintenance of the proposed tunnels, and I am not sure that movement of slide material within these areas, can be stopped without the expenditure of a great deal of money.

It is possible to avoid the areas of apparent surface slippage in the areas A and B by maintaining a tunnel line similar to the line of the northern boundary of the land included in Lincoln Park and deeded to the City by the Sutro Estate. This line continues westerly to the site of the proposed plant. I consider that with a stabilization of the areas A and B by proper drainage, such a tunnel line is suitable for the proposed tunnel

up to the point where it enters the area C.

The area C must be carefully drilled and studied before a decision can be reached as to the possibility of erecting a plant in this area. If a safe plant site is finally determined, its location will fix the alignment of the connecting tunnel link. The area to be drilled is from 30 to 50 feet above sea level and as soft mud is oozing out at the shore line, any test hole must be carried to some distance below sea level. I consider that at least forty holes should be drilled in the area of the proposed plant site, (300 feet by 500 feet), which would allow four rows (10 holes spaced 50 feet apart), of holes at intervals of 100 feet. The hundred foot spacing should be North and South. The fifty foot spacing East and West.

Any tunnel from the outfall of the 48th Avenue sewer to the site of the proposed plant will enter the Cliff Line near the slide area D. This slide is associated with a series of steeply tilted, thin-bedded strata which rise from below the shore level and form a part of the cliff face at this point. The general strike of the up-tilted strata is southeast and the dip is to the east. The tunnel should enter the cliff west of the area D and attain a distance in the cliff at least 200 feet south of the line of the path I have shown along the cliff line, before turning in the direction of the site chosen for the plant.

A tunnel with such an alignment would have the advantage of approaching the plant site along a line about at right angles to the line of the mass of serpentine which rims the plant site along its western edge.

The alignment suggested would call for some 5200 feet of tunnel from the east line of Lincoln Park to the outfall of the 48th Avenue sewer tunnel. The greater part of this distance would be through the sediments of the Franciscan Series. Two serpentine belts will have to be cut through, and, depending upon the grade chosen for the tunnel, it is possible that crossing through the serpentine will be necessitated a third time. The three serpentine areas should be cut in about 600 feet of tunnel.

I have made considerable inquiry concerning the rock conditions of the ocean floor in the vicinity of Mile Rock because of your desire to consider a possible outlet tunnel into this area.

The following letter received from the Bureau of Lighthouses, Washington, D.C., expresses the information so far available.

"DEPARTMENT OF COMMERCE

BUREAU OF LIGHTHOUSES

WASHINGTON

November 12, 1934.

"Mr. Thomas V. Reeves,
1200 Crocker First National Bank Building.
San Francisco, California.

Dear Sir:

"Reference is made to your letter of November 8, 1934, requesting certain information in regard to rock formation at the site of Mile Rock Lighthouse in San Francisco Harbor.

"A search of the available records at the Bureau fails to reveal any information in regard to the nature of the rock except a meagre item contained in a clipping from the San Francisco Call for the year 1905 describing the construction which states 'A wall ten feet in diameter was driven through the rock down to high water level, with a pump room at the bottom. No dynamite could be used owing to the softness of the rock.'

"As this construction was carried on by contract, it is believed whatever records of rock formations, if such exist, would be found in the offices of the contractor whose name was McMahon according to the article quoted, or at the office of the Supt. of Lighthouses, San Francisco, Cal.

"This contract was under the direct supervision of the 18th Lighthouse District which office is now located in the Custom House, San Francisco. Your letter will be referred to that office for any further information which they may be able to supply you directly.

Very truly yours,

For the Commissioner:

(Signed) C. A. Park
Chief Engineer."

GBS:ORM

The records of the Corps Engineers' office, 9th Corps Area, were destroyed in the Flood Building in the fire of 1906. The records of the Superintendent of Lighthouses in San Francisco, were destroyed in the same fire.

Mr. Jenkins from the office of the Superintendent of Lighthouses, Mr. L. S. Griswold, 9th Corps Area, Presidio and Capt. H. Pond, Engineers' Office, Customs House, state that there are no records available, but that the concensus of opinion is that the rock on which the Mile Rock Light is built, is similar to the sandstone of the cliffs near Lands End.

In the absence of definite data as to the position of the outlet or the conditions of the ocean floor along the site chosen, it is impossible to make a definite statement on this subject. I consider that with proper drilling along the shore line, to determine an area of massive sandstone, that a tunnel could be carried at a proper depth for a considerable distance, from the shore line in a general northwesterly direction.

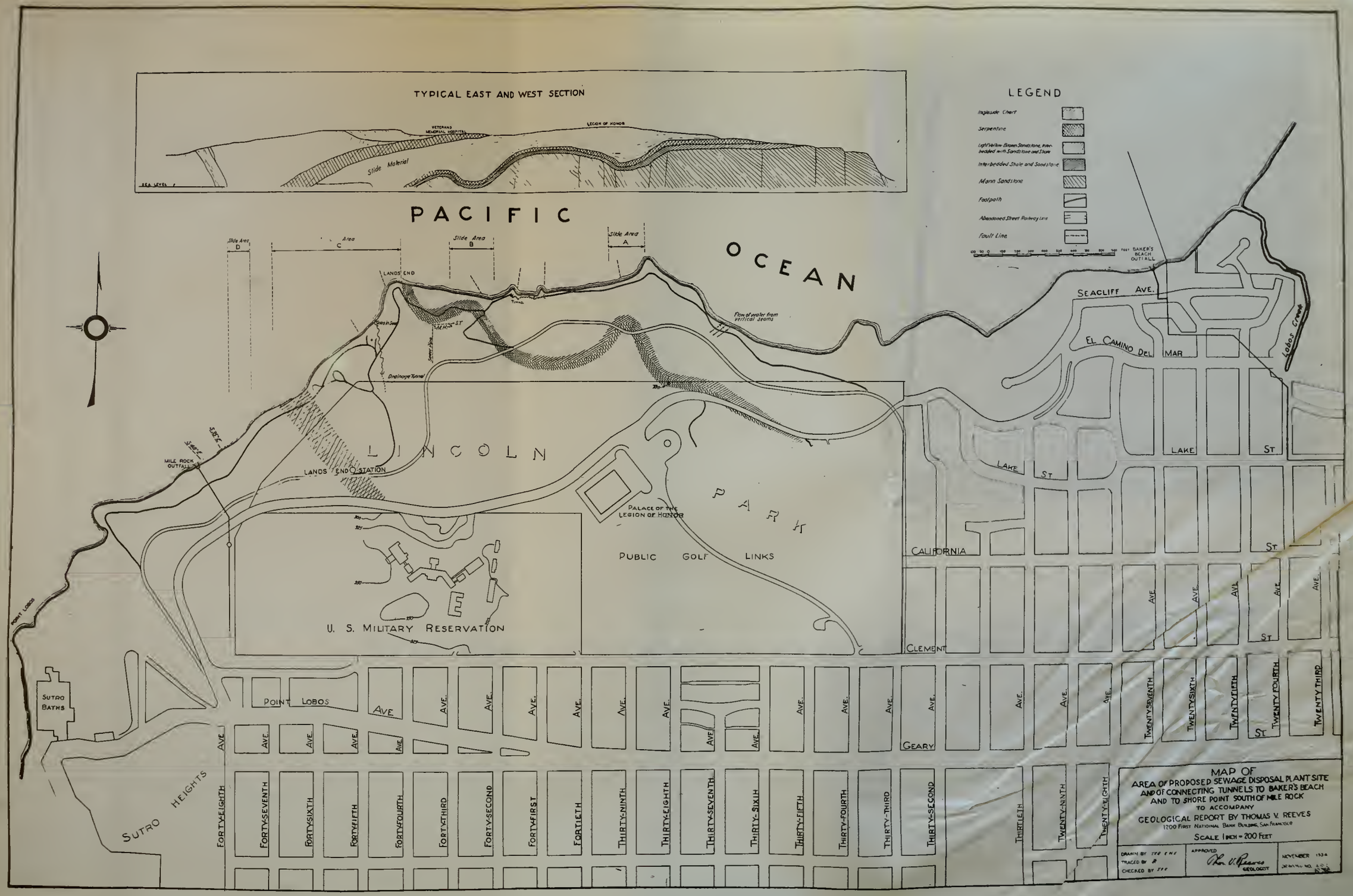
A careful study of the charts and other available data as to depths of water, reef conditions, etc., must be made to decide the feasibility of any particular site for this outlet, and also to arrive at the elevation below surface at which it would be safe to carry on this work.

CONCLUSIONS:

I consider the site at Lands End, in view of the data now obtainable, as unsuited for the proposed plant and tunnels and recommend that further consideration of this site be dropped, unless definite proof of its fitness is submitted.

Respectfully submitted,

(Signed) Thos. V. Reeves


TYPICAL EAST AND WEST SECTION
VETERANS MEMORIAL HOSPITAL
LEGION OF HONOR
Slide Material
SEA LEVEL
LEGEND
Inglewood Chert
Serpentine
Light Yellow-Brown Sandstone, interbedded with Sandstone and Shale
Interbedded Shale and Sandstone
Mann Sandstone
Footpath
Abandoned Street Railway Line
Fault Line
FEET BAKER'S BEACH OUTFALL
PACIFIC
OCEAN
Slide Area D
Area C
Slide Area B
Slide Area A
LANDS END
Flow of water from vertical seams
Drainage Tunnel
MILE ROCK OUTFALL
LANDS END STATION
LINCOLN
PARK
PALACE OF THE LEGION OF HONOR
PUBLIC GOLF LINKS
U. S. MILITARY RESERVATION
SEACLIFF AVE.
EL CAMINO DEL MAR
LAKE ST
CALIFORNIA ST
CLEMENT ST
GEARY ST
POINT LOBOS AVE
SUTRO BATHS
SUTRO HEIGHTS
FORTY-EIGHTH AVE.
FORTY-SEVENTH AVE.
FORTY-SIXTH AVE.
FORTY-FIFTH AVE.
FORTY-FOURTH AVE.
FORTY-THIRD AVE.
FORTY-SECOND AVE.
FORTY-FIRST AVE.
FORTIETH AVE.
THIRTY-NINTH AVE.
THIRTY-EIGHTH AVE.
THIRTY-SEVENTH AVE.
THIRTY-SIXTH AVE.
THIRTY-FIFTH AVE.
THIRTY-FOURTH AVE.
THIRTY-THIRD AVE.
THIRTY-SECOND AVE.
THIRTIETH AVE.
TWENTY-NINTH AVE.
TWENTY-EIGHTH AVE.
TWENTY-SEVENTH AVE.
TWENTY-SIXTH AVE.
TWENTY-FIFTH AVE.
TWENTY-FOURTH AVE.
TWENTY-THIRD AVE.
MAP OF
AREA OF PROPOSED SEWAGE DISPOSAL PLANT SITE
AND OF CONNECTING TUNNELS TO BAKER'S BEACH
AND TO SHORE POINT SOUTH OF MILE ROCK
TO ACCOMPANY
GEOLOGICAL REPORT BY THOMAS V. REEVES
1200 FIRST NATIONAL BANK BUILDING, SAN FRANCISCO
SCALE 1 INCH = 200 FEET
DRAWN BY
TRACED BY
CHECKED BY
APPROVED
GEOLOGIST
NOVEMBER 1934
DRAWING NO.